10th International Conference

mobile learning 2014

Madrid, Spain
28 February - 2 March

PROCEEDINGS

Edited by:
Inmaculada Arnedillo Sánchez
and Pedro Isaías

iadis
international association for development of the information society

10th INTERNATIONAL CONFERENCE ON

MOBILE LEARNING 2014

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ON
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MADRID, SPAIN

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Organised by
IADIS
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Edited by Inmaculada Arnedillo Sánchez and Pedro Isaías

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FOREWORD

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The Mobile Learning 2014 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 2014 received 83 submissions from more than 29 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 28 full papers were approved which means an acceptance rate of 15%. A few more papers were accepted as short papers, reflection papers and poster. 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 and poster also included a keynote presentation from an internationally distinguished researcher. We would therefore like to express our gratitude to Professor Steve Benford, Professor of Collaborative Computing in the Mixed Reality Laboratory at the University of Nottingham, UK, for accepting our invitation as keynote speaker. In addition, Mobile Learning 2014 features a Panel that is chaired by Nicole M. Kendall, Tennessee State University - Nashville, TN, USA and Robbie K. Melton, Tennessee Board of Regents - Nashville, TN, USA

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 Madrid and their time with colleagues from all over the world, and we invite you all to next edition of the International Conference on Mobile Learning in 2015.

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Conference Program Chair

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KEYNOTE LECTURE

CRAFTING AND GIFTING MOBILE LEARNING EXPERIENCES

By Professor Steve Benford, Mixed Reality Laboratory,
The University of Nottingham, UK

Abstract

Gifting is a powerful social dynamic. Handmade gifts in particular can be personalized to a recipient and bring a social obligation to take them seriously, comment on them, and perhaps even reciprocate. I will explore how we can empower people to create personalized learning experiences as gifts to others, especially to close friends and family. I will draw on recent projects in art galleries in which we enabled people to create their own mobile tours for a partner or close friend that the couple then experienced together, and will reveal how these led to deep, personal and sometimes even provocative interpretations. I will also consider how people can create physical-digital gift objects that can be associated with personal memories and so encourage reflection. I will conclude that this distinctive dynamic of gifting may open up powerful new approaches to the longstanding challenges of personalization, interpretation and collaboration that concern galleries, museums and many other learning environments.

PANEL SESSION

UTILIZING MOBILE TECHNOLOGIES TO ENRICH PROFESSIONAL CONFIDENCE IN MILLENIAL TEACHERS

By Nicole M. Kendall*, Ed.D. and Robbie K. Melton, Ph.D.**
***Tennessee State University - Nashville, TN, USA**
****Tennessee Board of Regents - Nashville, TN, USA**

Abstract

This session will explore some of the challenges utilizing technology for instructional purposes, strategic professional development measures, and mobile technologies to support Millenial teachers. The audience will contribute their approached to professional development to offer a dialogue towards global support of teacher effective and mobile use.

Keywords

Mobile, technologies, Millenials, confidence, learning, devices

1. INTRODUCTION

Today's networked society invites a greater use of technology among Millenials learners. This trends places a higher burden on educators to rethink the role and types of strategies applied in "formal" education, especially when engaging the minds of digital learners. Not since the days of the Renaissance, have online users been motivated to interact beyond their communities, and seek to investigate the world. These youths rely on mobile technologies to build relationships with individuals based on commonalities, life experiences, or personal interests. This growing trends and desire to "stay connected" is applicable to the launch of lighter, inexpensive mobile devices that promise more applicable and features to promote 21st century learner strategies.

Teacher resistance to technology use can be linked to their own comfort to utilize digital resource in the classroom. For novice educators (and those in teacher preparatory programs), this hesitation serve as an ironic instructional setback due to their familiarity and usage of mobile technologies in their everyday lives. Natural engagement to social medias and collaborative networks demonstrate user ability to incorporate technology into various aspect of the instructional environment. Yet, Millenial educators must view these

21st century tools as a professional attribute in their own experience (and growth) to increase the infusion of mobile technologies and digital competencies in their students.

Consistent with the aims of quality professional development, this presentation centers on two core questions: 1.) Can mobile technologies increase practitioner dispositions in Millenials teachers with strategic professional developments and, 2.) Can Millenial teachers better articulate digital excellence in instruction using mobile technologies in professional development? As more mobile devices are being introduced in the learning environment, Millenial educators must receive the necessary guidance to shift their technology use from social-networking to instructional-applying.

2. BODY OF PAPER

At its most basic level, technology is being used to cross the boundaries between formal in-school education and information education where students explore their own interests (MacArthur Foundation, 2008). The use of technology that did not exist 10 years ago allows for a degree of freedom and autonomy for Millenials that has yet to be explored fully in the classroom setting. Digital learning of the 21st century provides easy access to resources through application (apps), digital libraries, and even human experts through video conferencing and social networking. This engages students in ways that are fundamentally different from traditional instruction (Ito, M. et. Al, 2008).

Attitudes of teachers toward technology use within the schools are important and often an overlooked component of successful curriculum integration of technology (Alexiou-Ray, et. Al, 2003). Educators cannot ignore the impact of technology and the changing face of curriculum. Since attitudes toward technology are linked to such important outcomes; such as willingness to undertake development in technology-supported activities, resistance to technology use, and success in sing technology in a new context (Keith, 1993), understanding the processes that shape these attitudes are essential to developing inventions to improve them.

According to O'Connor (1997), "It is a truism in media that educators first tend to use new technology the same way they used to using older technology." Decades later, this holds true for mobile technologies in which educators see to apply its functions to stationery (desktop) computer. Yet, the multi-functional instructional tools of a mobile devices (camera, internet access, content-related apps, email, video-conferencing, etc.) are ignored and replaced by similar, individualized equipment that are familiar from teacher education preparation program or their own classroom experiences.

3. CONCLUSION

Mobile technologies are changing the way students learn: playing complex video games, interacting with simulations that put them in challenging situations, taking advanced courses to enrich studies, and more. These "on the go" tools create learning opportunities that challenge traditional professional development for Millenial teachers whose experiences with technology is more from a student (social user) standpoint. There is still relatively little research that investigates how the dynamics of working with mobile technologies influence the way educators deliver content and the way digital students learn

(MacArthur Foundation, 2008). Regardless of the device, educators must be ready to engage students in the world's classroom – which spans beyond the pages of a textbook and the walls of their school.

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Full Papers

SUPPORTING TEACHERS TO DESIGN AND USE MOBILE COLLABORATIVE LEARNING GAMES

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ABSTRACT

Mobile Collaborative Learning Games combine all the ingredients necessary to attract students' attention and engage them in learning activities. However, designing a coherent scenario that combines mobility, game mechanics and collaborative learning is quite a challenge. In this article, we take the first step by proposing several game patterns that naturally integrate these mechanics in order to support educational goals. We also discuss ways to support teachers design these applications and adapt them to their course material and specific learning situations. Finally, we identify the technical challenges linked to the deployment of these applications such as connectivity between mobile devices, geolocation, real time adaptation of scenarios by teachers and the use of data collected on the field as course material.

KEYWORDS

Mobile Learning, Learning Games, Collaborative Learning, situated Learning, Game mechanics, adaptation

1. COLLABORATE, PLAY AND MOVE

Teachers often feel the need to try innovative learning mechanics in order to motivate the new generation of students. In this first section, we describe three promising mechanics and their positive effects on learning.

1.1 Mechanics to Enhance Learning

Collaboration is widely used by teachers as a means to enhance learning (Freinet, 1993). This is not surprising, given the fact that group work facilitates learning through ***social interactions*** and increases the students ***personal engagement*** in the learning process (Doise *et al.*, 1975) (Johnson *et al.*, 1998).

Lately, the concept of Learning Games has also become popular for teaching various types of skills. The main idea is to use **game** mechanics such as competition, rewards, or simply curiosity in order to captivate the learners' attention and push them to learn (Dondlinger, 2007). When used correctly, these game mechanics enhance the learners' experience with ***emotion***, which has positive effects on engagement and memory (Damasio, 1995). These game mechanics also position the learner as the central ***actor*** and motor of his own learning experience. Even though learning games come in various shapes, such as simple card games or live role planning games, the latest ones tend to be designed as video games. This is not only because of the ***attractive*** and immersive nature of video games but also because computer applications can unload teachers from repetitive and time consuming activities so that they can concentrate on providing guidance and help to their students. Computer Learning Games can also provide automatic adaptation to the users profile and monitoring tools for teachers.

Finally, the use of **mobility** (with any kind of mobile device) for teaching has also increased now that a large amount of students own smartphones. For example, several systems offer pooling functionalities that teachers use during their lectures (Rubner, 2012). This allows them to get real-time ***feedback*** from each student and adapt their presentation accordingly. Mobility also opens the possibility of ***situated learning*** in various physical settings. For example, Ardito *et al.* (2012)and Loiseau *et al.* (2013) have designed mobile applications to teach students about the history of geological sites and cities while they are walking around them. This can also be very useful when teaching professional skills and gestures in real environments. For example, the *MARL* simulator (Jayfus and Kathleen, 2007) uses augmented reality to teach professional skills and psychomotor tasks on real car engines. Finally, mobility can be useful to explain a concept with ***live simulation***. The *Disease Simulation* (Colella, 2000), for instance, was designed to teach children how a virus spreads. The participants wear digital tags that indicate if they are sick or not and, the same way a real virus spreads, the virtual illness is propagated when the children get close to one another.

1.2 Combining Mechanics

While *collaboration*, *game* mechanics and *mobility* have proven to enhance learning on their own, we believe that their combination would be even more powerful because of the way they enhance and facilitate the use of each other. Even though a couple of researchers have successfully combined these mechanics, there is no study that identifies what makes this specific trio particularly powerful. In the next paragraph, we therefore identify and analyze the synergies between collaboration, game and mobility, represented as dotted arrows in Figure **1**. Note that, on the same figure, the positive impacts of collaboration, game and mobility on learning, described in the first section of this article, are represented by full arrows.

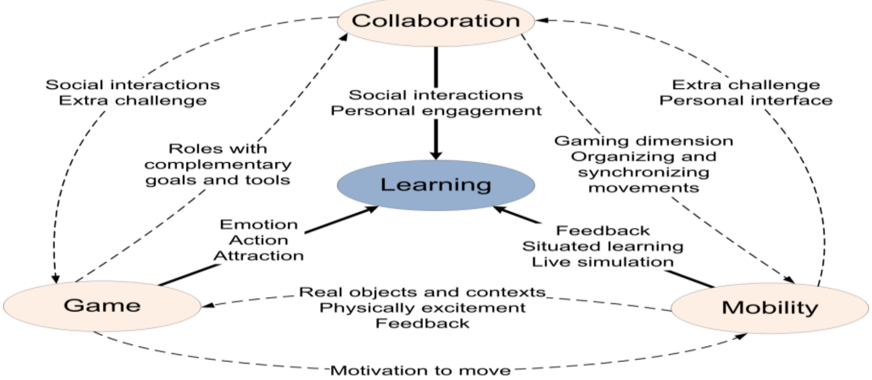

Figure 1. Positive interconnections between Collaboration, Game, Mobility and Learning

1.2.1 Collaboration and Game

Setting up collaborative learning activities, where all the members of a group participate equally, is very challenging. Gómez *et al.* (2013), argue that this is possible by designing the activities so that each of the students has a specific interdependent task he/she needs to achieve. In order to encourage the students to do their one tasks, they designed a game where three students each hold a mouse, connected to the same screen and, in order to win the game, the team needs to complete various tasks that can only be done with one specific mouse. In other words, the students are given different tools (in this case, a mouse), which allow them to complete complementary tasks, and therefore collaboratively achieve a common goal. We believe game mechanics provide a natural way of setting up such mechanics. Indeed, like in *Environmental Detective* (Klopfer and Squire, 2008), the game can be designed so players are given ***complementary roles*** (e.g. manufacturing company worker, environmental activist) with specific ***goals***, thus forcing each learner to speak for him/herself. The game can also push this principal further by giving specific ***tools*** and powers to these roles (e.g. sorcerer, troll, chemist) so that the students are the only ones capable of doing certain tasks.

On the opposite, the use of collaboration is also recognized as one of the mechanisms that enhances games (Björk and Holopainen, 2004). This is due to the ***social interactions*** and the ***extra challenge*** of team decision making.

1.2.2 Game and Mobility

Mobility offers new possibilities for enriching games and enhancing the users experience by taking advantage of ***real objects*** (e.g. plants, buildings, animals) in ***real contexts*** (e.g. archeological or geological site, factory, nature) (Daniel *et al.*, 2009). Several studies have also shown that ***physically excitement*** caused by walking, running or jumping during the game increases players engagement (Bianchi-Berthouze, 2013). Finally, smartphone functionalities such as GPS, accelerometer and other sensors that collect ***feedback*** can provide valuable information in order to improve engagement in the game. For example, if the player has been standing in the same area for a long time or has been going round in circles, the game could automatically provide some hint on what to do next.

On the opposite, game rewards such as extra points or unlocking the next part of the story, can also help ***motivate the learners to physically move*** to the next location. This is for example the case of *Rewild*[1], an adventure games that motivates non-hikers to discover the beauty of nature.

1.2.3 Mobility and Collaboration

If well designed, collaborative activities can greatly enhancement the concept of mobility. Indeed, by forcing the team members to ***organize and synchronize their movements*** in order to cover the whole map or to be at a specific location at a given time, collaboration can give a new ***gaming dimension*** to mobility.

On the opposite, mobility can lead to situations where the team members are physically dispersed and don't always have the means to communicate. These situations make collaborative activities much more ***challenging***. In addition, when working in collaboration, it often happens that the team members don't progress at the same speed. For instance, some of them might need to come back on certain activities or read the instructions again. With the use of ***personal mobile interfaces***, each student can navigate freely in the activities and submit their personal work when they feel ready (George and Serna, 2011).

As we have seen, several learning applications already take advantage of the synergies between *collaboration*, *game* mechanics and *mobility.* However, their design remains experimental; without any methods to make sure these mechanics are used to their full potential. In addition MCLG (Mobile Collaborative Learning Game) design is far from being trivial. Indeed, not only does it combine the challenges identified by researchers in Collaborative Learning, Learning Games and Mobile Learning such as designing coherent scenarios, reducing production cost and helping teachers and students adopt the applications but it also raises extra challenges resulting from the difficulty of combining these three mechanics. Given the power of this trio and the high demand for applications that motivate and engage students, we believe it is important to assist their design and use. In this article, we first put forward several solutions for designing coherent scenarios that integrate *collaboration, game* mechanics and *mobility* in such a way to create the desired synergy and facilitate the *learning* process. Then we discuss how to support teachers to use MCLGs and adapt them to their course material and their specific learning situations.

2. DESIGNING LEARNING SCENARIOS

As we have shown, MCLGs have all the necessary ingredients to engage students in learning activities. However, it takes more than just knowing the right ingredients to make a good cake. Indeed, the ingredients need to be carefully selected, dosed, mixed and cooked in a certain way in order to create the final enhanced product, that is much more than just an addition of all the ingredients. We believe designing MCLGs raises the same challenge: selecting, dosing and combining *learning* activities, *collaboration, game* mechanics and *mobility* in order to create synergies and hence, maximize educational value.

Because there are no recipes or authoring tools that provide guidance for designing MCLGs yet, we take the first step by proposing three game patterns that naturally integrate these mechanics and support specific educational goals. Bear in mind that this is just the first step, as we would also need to provide teachers with guidance and more examples in order to help them choose and use the right patterns.

2.1 Live Action Role-Playing Game

LARPs (Live Action Role-Playing games) are built around role playing activities guided by rules. Players usually have full control over decisions made by their character and the game scenario is completely dependent on their actions. LARPs are usually guided by a game master who facilitates the game flow, administrates the game rules and keeps score (Tychsen *et al.*, 2006). In terms of education, LARPs seem ideal for practicing social skills or understanding complex subjects that don't have a given solution and involving several actors. In addition, the role of the game master is perfect for teachers because it allows them to observe the learners and adapt the game scenario accordingly. A variation of this game type is to

[1] http://www.rewild.fr

strip the roles down to the minimum and focus on the rules that condition the interactions between the players. This can be used to create a participatory simulation of a specific mechanism such as the virus epidemic in the game Disease Simulation, described in the first section of this article.

Similarly to game design pattern libraries (Björk and Holopainen, 2004), we depict each MCLG pattern with a specific structure and an example. These examples are inspired by real games, designed and used by teachers at different levels of education.

Example 1. Pattern LARP - Fast way construction

Educational goal: Understand the mechanisms of democracy and practice how to defend an opinion by collecting data and presenting it orally.
Game: The town mayor has the project of building a fast way thought a section of his city. However, he would like to debate this project with the citizens before making a decision.
Mobility: With a map of the construction plan for the road, the players need to investigate on the field to find elements that are in favor or against the construction of the road. Regularly, the players are summoned to a general town meeting to present and discuss their point of views on the road project.
Collaboration: At the beginning of the game, the players are assigned to complementary roles so that they represent the town population:

- The mayor would like his town to grow but doesn't want to go against the general opinion
- Citizens who live next to the construction area and would be bothered by the noise
- Citizens who would be able to reduce their transportation time by taking the fast way
- Local store managers who would increase their sales if the fast way was built
- Environmental activists who want to protect the bird sanctuary, the road will go through
- Owners of construction companies who would be able to hire people to work on the road
- Two journalists, one in favor and one against the road construction, who need to conduct surveys on the general opinion and keep the population informed of the local news

Note that the scoring mechanism is different for each role and is designed so that the players will need to negotiate and come up with a solution that suits all the participants. However, the teacher that used this game noticed that, even though the scoring mechanism seems to motivate the students in the beginning, they often forget it completely by the end of the game.

2.2 Mystery Game

The scenario of a mystery game is built around a central mystery that players need to solve by collecting clues, analyzing them and deducting possible solutions. This model is very similar to the case-based teaching method that consists in presenting learners with a problem, inspired by a real situation, and putting them in the position of decision makers. We believe this game model is therefore perfectly adapted to make students practice the use of theoretical knowledge through collaborative resolution of complex cases. These cases can cover a very large variety of educational domains: finding what pathology a patient is suffering from, understanding what broke a piece of machinery, finding the best solution for a divorce case (Marfisi-Schottman *et al.*, 2013)...

Example 2. Pattern Mystery game - Company investigation

Educational goal: Practice how to use decision making tools on a real complex problem.
Game: The students are hired by a company to understand why it has been losing so much money lately. They have a limited time to identify the problem and find solutions.
Mobility: The players need to physically go to various rooms of a building in order to investigate. They collect information, such as videos of fictional employees being interviewed or important documents, by scanning the QR codes in each room. The teacher regularly gathers all the students to discuss their finding and reflect on the decision making tools they can use to help them.
Collaboration: In order to finish the game in time, the players, in groups of three, needs to organize and divide their tasks. For example, in the beginning of the scenario, each player decides which rooms he/she is going to visit in order to collect information and, in the next phase, when they have several hypotheses on what is causing the money los, they also need to divide the work for further investigations.

2.3 Treasure Hunt

A treasure hunt is a game in which players attempt to find hidden items with a series of clues. Because this type of game pushes players to explore the environment and get familiar with it, we think it is very well suited to teach about the characteristics of real items, locations and environments.

Example 3. Pattern Treasure hunt - Bacchus' party

Educational goal: Learn about life in Ancient Rome and the end of Pompeii.
Game: The players are hired by Bacchus to organize a party in his honor. They are given a list of items that they need to find (beverage, food, gests and animations) and a certain amount of gold coins. However, the amount of money is not sufficient, so the players will have to make a decision: only buy what they can, and therefore score very low on Bacchus' happiness scale, or steel! If they steel, the volcano will start showing signs or eruption and the virtual inhabitants of Pompeii will tell them that it is God who is angry at the sinful population. At the end of the game, whatever the decisions made by the players, the volcano erupts anyway, just like it really happened. If they stool, God starts the eruption and if they didn't steel or didn't collect all the items in time, and therefore didn't fulfill Bacchus' expectations, his fury triggers the eruption.
Mobility: The students have a few hours to physically go around the ruins of Pompeii and find the items they need in the real locations where the shops where. To find the gests and animations, they have the choice between the house of poets and dancers, the gladiator barracks and several villas of noble families.
Collaboration: In order to collect all the items in time, the players need to divide their tasks. When they realize the shortage of money, they will also need to contact each other and decide what strategy to adopt.

These three design patterns are first steps toward designing motivating and educationally rich MCLGs. However, this is far from being sufficient to get teachers to use MCLGs in their class. Indeed, not only do teachers need to feel at ease installing and using these games but their content and shape also need to be compatible with their educational context (e.g. student's level, curriculum, number of students). In the next section, we discuss solutions to meet these expectations.

3. PLACING THE TEACHER IN THE CENTER

When considering the multitude of learning applications developed for research, it is surprising to see how few of them are actually used by teachers. This can party be explained by the obsolescence of hardware and software but it is mainly due to the fact that the educational content and the shape of the applications simply don't meet the teacher's needs. In some cases, especially for Learning Games, the applications are designed without the presence of teachers (Ketam *et al.*, 2013). In this case, they are quite unlikely to integrate the pedagogical structure that teachers need for their courses. In most cases though, learning applications are designed with the help of one teacher but they are therefore tailored for that specific teacher and one particular educational context. Because these applications leave very little room for adaptation, without any computer skills, they often cannot be used by other colleagues or even by the same teacher but with another class (Marne *et al.*, 2013). This rigidity causes most applications to be put away and forgotten after just a few years. Another reason that can explain the fact that learning applications are rare in school is that they are often set up by professional computer scientist and, unless the teachers are very skilled with computers, it is highly improbable they will be able to set them up again if there is a technical problem or if the school is provided with new computers and mobile devices.

In order to get the maximum number of teachers to use MCLGs, we therefore believe it is necessary to place them in a central and active role during the design process and the use of these applications. In the next section, we provide leads on how to design tools to help teachers:

- **design** their own MCLGs and **understand** the mechanisms under the lid to adapt them
- **monitor** the student's progression in the game and **adjust** the scenario in real time
- easily **deploy** MCLGs on the available mobile devices and fully integrate them to their course

3.1 Design and Understand

Before using any kind of tool in class, teachers feel the need to test it and understand the way it works. This is a necessary step to decide if the tool corresponds to their needs and to plan how they want to use it with their students. This step is a big concern to teachers, especially when dealing with unknown game mechanics. Indeed, if it is not clearly stated, it is difficult to imagine how they can impact a course. The fear of not being able to control students when they are "frantically playing" is often enough to discourage teachers.

In order to design MCLGs that correspond to the teacher's needs, and help them understand the game mechanics, we believe it is indispensable to involve them in the design process as early as possible. In the field of Learning Games, this challenge has been answered with two different strategies. The first solution is to help teachers design games with the help of game designers. In order to help them understand each other and work in an efficient way, several authoring tools have been developed (Marfisi-Schottman *et al.*, 2010). This solution has the advantage of providing original game scenarios, custom-tailored to fit the teacher's needs however, as you can image, the services of a game expert and the development cost are not affordable by many schools. The second solution consists in providing teachers with premade game-shells in which they can add their educational content. These shells often come with more or less complex editors that allow teachers to generate their own functional applications for a very low cost, because they need little or no help from developers and graphic designers (Thiagarajan *et al*., 2003) (Mehm *et al.*, 2009) (Marfisi-Schottman *et al.*, 2013).

Because one of our goals is to widen the use of MCLGs to all types of schools and levels of education, we believe that building on the second solution is the most promising. However, in our opinion, the existing authoring tools, such as *eAdventure* (Moreno-Ger *et al.*, 2008) and *Storytec* (Mehm *et al.*, 2009), are fare from answering the teacher's needs and there is still quite a few improvements to make. The most important drawback is the very limited selection of game-shells that exist. Providing game-shells that correspond to the MCLG patterns we proposed in the second section of this article would be a good start to address this issue. The existing editors also lack flexibility and it is very difficult for teachers to compose a scenario that fits exactly to their needs. Finally, we believe authoring tools also need to provide information on the game mechanics and the education situations that they create, in order to help teachers choose the right games and use them correctly.

3.2 Monitor and Adjust

When giving a course, teachers naturally adapt the content (e.g. formulation of sentences, order of exercises, adding questions) depending on the student's achievements and emotions (e.g. facial expressions). If we want teachers to feel at ease with MCLGs, they must also provide them with feedback on the student's actions and allow real-time control over the events.

For this purpose, Carron and Marty (2012) recommend using monitoring tools that enable teachers to view the progression of their students through the game. Because students might be running around in the fields when using MCLGs, these tools could also provide information on their physical and logical location. They could also show large grain information such as "student needs help" or "student is in advance" when certain patterns are identified in lower level data, collected from the GPS tracks, scoring and feedback.

We believe teachers should also be able to adjust MCLGs' scenarios when they identify a problem. These adjustments can be done for one student in particular (e.g. sending a hint or an extra quest) or for all the students by adapting the global scenario (e.g. stopping the game, deleting a part of the scenario). In any case, given the mobility of MCLGs, teachers should have the means of communicating with a particular student or with the entire group at the same time. The intervention of teachers is also a good way of making game scenarios more interesting and unpredictable. In *Laboratorium of Epidemiologie* (Ney *et al.*, 2010) for instance, the students are not aware that one of the important characters is piloted by the teacher. Not only does this allow the teacher to subtly adapt the level of difficulty to the student's profile but the students also seem to accept negative comments coming from the game characters much better than if they came directly from the teacher. In certain cases, it might also be interesting to let teachers pilot the whole scenario of events depending on the student's reactions. For instance, Ponder *et al.* (2003) designed a simulator in which the students have to provide first aid care and, depending on the actions of the learner (e.g. moving the body, heart massage), the teacher triggers other events (e.g. person goes unconscious, starts bleeding). The idea is to adjust the scenario so that is pushes the student into a stressful state.

3.3 Deploy

The execution of MCLGs is a real challenge of its own. Indeed, these applications not only need to be functional on various mobile devices but the content collected during the field expedition must be easily transferable to desktop computers in order to be further analyzed and used as course material (George and Serna, 2011). Ideally, if the teachers use a LMS (Learning Management System), their student's achievements in the game should also be added into this system. We believe the new Tin Can API[2] seems to fit the purpose but needs to be further tested. Indeed, this API allows collecting data about the wide range of experiences a person has from various inputs (e.g. LMS, mobile applications, social networks, Web activity).

In order to support collaborative scenarios and their real-time adaptation by teachers, MCLGs scenarios also need to be executed by a centralized game engine that orchestrates the activities depending on the learner's actions and roles. Such a flexible orchestration could, for example, be possible with IMS-LD[3] modeling. Indeed this E-learning standard is recognized by course designers and executable by many online tools. However, it has been criticized for the difficulty of modeling collaborative activities and its level of abstraction too far from teachers' practices. One of the future research challenges is therefore to propose a model for designing MCLGs, that can be easily understood and manipulated by teachers, and that can also be transform into an executable IMS-LD model.

4. CONCLUSION

In this article, we discuss the way *collaboration*, *game* mechanics and *mobility* can engage students and enhance their *learning* process. We also show that, when these three mechanics are combined in a MCLG (Mobile Collaborative Learning Game), they create synergies and should therefore be even more effective. However, for the time being, there are no tools or methods to help teachers design and use MCLGs in class in such a way to obtain these synergies.

In order to address this issue, we first provide three game patterns that can be used as models for designing MCLGs: live action role-playing games, mystery games and treasure hunts. These patterns naturally create the synergies between collaboration, game mechanics and mobility and fit a large range of educational goals such as understanding complex mechanics, practicing professional skills in the real context and learning about situated objects and environments. We then put forward the challenge of making teachers use learning applications, such as MCLGs, in their class. We believe the best solution is to involve teachers as early as possible in the design process of MCLGs and also provide them with tools to monitor their student's actions and adapt the game scenario in real time. As a first step toward the technical deployment of MCLGs, we also identify the existing tools that could be put together in order to obtain a game engine capable of multi-platform execution, multi-role scenarios, real time scenario adaptation and exporting the data collected on the field to be used as course material.

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EBOOKS AS PDF FILES, IN EPUB FORMAT OR AS INTERACTIVE IBOOKS? DIGITAL BOOKS IN PHYSICS LESSONS OF SECONDARY EDUCATION

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ABSTRACT

This paper outlines the different capabilities of ebooks in the pdf, epub and ibook format in science teaching evaluated at the BG/BRG Schwechat. Over the recent years the school equipped with 100 personal computers and 28 iPads has become one of the leading e-learning schools in Austria.
iPads show their advantages in the context of blended learning sequences: the devices are instantly ready to use and allow pure haptic interaction with the content. The iPad appeals with its simple interface and very stable operating system. It encourages teachers to implement e-learning with the usage of ebooks into their lessons.
Significant differences between ebooks as pdf format, epub format and ibook format are evident in the integration of interactive elements: only ibooks support the integration of various interactive objects beside basic functionalities like the use of dictionaries and tagging tools. This format of ibooks meets the demands of teachers and pupils in ebooks in almost every point with the disadvantage that they are available only for iPads.
The creation of ebooks goes smoothly with the use of the software pages available for Mac OS and iOS, which is appropriate for the epub format, the production of interactive ibooks succeeds with the software iBooks Author available only for Mac OS.
The evaluation of this paper was done with the feedback tools of the learning platform Moodle asking students about their views. Through two e-lectures with teachers and a presentation at the national conference called “Tablet User Days 2013” at the Pedagogical University in Melk, a validation of this work was accomplished.

KEYWORDS

ebooks, e-learning, mobile – learning, tablets, competence– based science teaching

1. INTRODUCTION

Our world has developed in last decade to a place at which a life is hardly conceivable without digital devices and online tools. In the professional life and occupational world profunde knowledge of new technologies is essential. Desktop PCs, tablet computers and Smartphones are fixed components of our everyday life. New digital developments arise and influence our everyday life. Nowadays above all young people can hardly live without internet, mobile phone or computer.

The digital world, which is an important component of the social life of many youngsters, wins a bigger and bigger meaning in schools during the last years.

At many schools the use of online learning tools and platforms spreads more and more, during the last years there were initiatives over and over again to make the digital work in the classrooms the standard. *(Hummer et al., 2013)*

The benefits that come with the use of learning platforms for educational purposes have been evaluated and tested excessively in various national and international projects. A prime example of such a project in Austria is the eLSA project which has resulted in the implemented of e-learning in everyday school life in over 200 schools. *(Hummer et al., 2013)*

Young people spend a large part of their time online, social interaction, procurement of information, entertainment and still a lot more youngsters search today in the virtual world.

Under these conditions digital learning platforms and the reinforced application of new media in teaching affects positively the learning process.

However, during the last years an important area of the learning and teaching remained far behind the use of digital tools: the schoolbook. Schoolbooks are used like in recent decades still as workbooks or textbooks printed on paper, which pupils carry in her schoolbags to the school and home again.

The results of the „Kids & Family Reading of report in 2012" show that the amount of the children who have read an eBook has risen from 2010 to 2012 on 46% and has almost doubled. *(Harrison Group, 2012)*

In this work the question is discussed which kind of eBooks can improve the quality of teaching and learning in Physics in secondary education. As there are only very few ebooks offered as schoolbooks for physics lessons by educational publishers the possibilities for teachers to create ebooks are examined.

2. DIGITAL BOOKS IN PHYSICS LESSONS

There is a huge emphasis on competence- based learning and practical orientation in teaching natural science. In order to further improve on these concepts the competence model sets not only standards in the field of acquiring knowledge but also in the field of acquiring learning skills such as: organizing knowledge, gaining insight, drawing conclusions and designing. *(Hopf, et al. 2012)*

The implementation of interactive graphs and digital animations makes it easier for students to understand complex processes in natural science. (*Ebner, et al. 2011)*

This leads to the assumption that digital books with the integrated feature of displaying digital content support pupils to achieve their learning skills.

Digital books as pdf files, in ePub format or as interactive ibooks – which kind of ebooks can be used in the framework of competence based teaching and satisfy the requirements of a modern school with a focus in elearning?

The approach to answer the research questions was done in 3 fields:

1. What are the requirements of teachers, who have experiences with teaching and learning with PCs and iPads as well as with learning platforms, in eBooks?
2. Which software on a Windows PC or on a computer with Apple Mac operating system is suitable for a teacher to create interactive eBooks without programming knowledge?
3. Pupils at the age of 13 and 14 years experienced with eLearning with PCs and iPads were asked for their opinion about learning with eBooks.

2.1 Description of the Sample of Pupils and Teachers and the Didactic Approach

At the BG / BRG Schwechat for several years now, the focus has been on eLearning, using 3 computer rooms with a total of over 100 PCs.

The BG / BRG Schwechat is a school with about 1000 students aged 10 to 18 years, employing about 90 teachers. To allow eLearning not only in computer rooms but also in all 40 classrooms, a mobile solution was implemented: There are 28 iPads stored in a cart, which makes transportation and synchronization of the devices easier. This mobile e-learning unit is available to all teachers as long as they reserve via a custom made reservation system accessible online. In order to optimize this system a projector was installed in every class room and full Wi-Fi coverage was set up in all parts of the school building.

The teaching methodology of the e-learning sequences in physics was developed in cooperation with the committee for "new graduation standards for Physics" and meets the requests of the competency model for physics.

Competency based teaching has become very important especially in teaching natural science. In order to further improve on the concept the competency model sets not only standards in the field of acquiring knowledge were defined but also in the field of acquiring learning skills such as: organizing knowledge, gaining insight, drawing conclusions and designing. *(Hopf, et al. 2012)*

The lessons for this study were designed following the concept of "inquiry based learning" based on investigation of questions asked in the subject physics. Questions and working instruction were provided at the learning platform moodle, students were able to log in using the Safari browser of the iPad.

To answer the questions mentioned above about digital books for teaching purposes, the following approach was chosen: a sample of 7 teachers teaching scientific subjects and with some experiences with learning platforms and other digital media was interviewed about their requirements to digital school books. As another aspect it was examined whether digital schoolbooks, which are offered by schoolbook publishers correspond to the demands expressed by the teachers.

In order to investigate the feedback of pupils to the use of ebooks the author provided 2 ebooks covering topics of the curricula of the 4th grade. 25 pupils of a 4th class aged 13 and 14 had the possibility to collect practical experiences with learning with ebooks during their physics lessons. Implementing the blended learning approach pupils chosen for this project had collected experiences in the use of the learning platform moodle as well as in learning with iPads.

As didactic approach the learning model of inquiry based learning was chosen: first pupils compiled tasks of a chapter with the help of the physics book; beside the school book iPads were used to communicate with the teacher on the moodle platform and to deliver results of pupils' work or to answer online test questions. As next step the author of this work wrote an ebook provided as pdf format. Using this ebook pupils had to compile a chapter of the curriculum without the use of the printed physics book.

The next chapter of the curriculum the pupils had to manage with an ebook provided as an epub file.

In order to get informed about the topic *light and shadow in Astronomy* the interactive ibook "Solar Eclipses" written by the author was used by the pupils.

As already mentioned every pupil had the possibility to use an iPad at school and ebooks were read in each case with an iPad. iPads were available to the pupils in the concept „iPads for everybody - the mobile computer lab" only at school, pupils had not the possibility to work with iPads at home.

To compare the capabilities of programs offered for the creation of ebooks the free software Calibre (available for Windows and Mac OS), the program Adobe InDesign (available for Windows and Mac) as well as the Mac OS software Pages and iBooks Author were used; in addition pupils used the application "Book creator" with the iPads to produce an ebook in the epub format.

After the pupils had finished their tasks using and creating ebooks, they were asked with the help of the anonymous feedback tool integrated in moodle about their opinion about their learning experiences.

Figure 1. Learning with interactive ibooks

2.2 Requirements in ebooks – Investigation of Various Formats

Asked about requirements in ebooks for teaching purposes all teachers mentioned at first that it should be possible to make comments and to highlight text. The vast majority of the interviewed teaching staff expect the following basic functionalities from ebooks for the use in scientific teaching: ebooks must be easily available for mobile learning on tablet PCs, ebooks must offer an easy browsing to pages or chapters, display of hyperlinks in a browser as well as searching functions and bookmarks.

Moreover, the surveyed teachers expressed that ebooks which satisfy the didactic needs of the method of inquiry based learning should allow to set marks and notes, an access to dictionaries or encyclopaedia should be integrated and interactive quizzes and tests to verify educational objectives should be available. Functionalities supporting collaborative learning are also desirable.

It was agreed by everybody that the usage of multimedia content like photos, videos and 3D animations in scientific teaching proves an essential advantage of ebooks in comparison to books printed on paper.

Approved digital schoolbooks offered by publishers in Austria fulfil the requirements mentioned above only to a low part: the printed schoolbooks are offered as a digital version which are readable only after the installation of software from a CD at a PC, in a network or on a tablet PC they are not available. Digital schoolbooks are based on printed books, with some additional functions, which claim to support teachers in preparation of their lessons, multimedia contents is complete absent.

The comparison of different formats of ebooks results in the following findings:

Ebooks available as pdf files offer no multimedia and interactive contents, however, they can be read with the help of an ebook reader application on a tablet PC. Ebook readers are offering searching functions and access to dictionaries which allows looking up in an encyclopaedia, and however, also on the internet.

If one wants to add remarks or notes to an ebook in pdf format, this is only possible when the ebook is opened on the tablet with another application as for example "Good Reader".

The epub format allows the display of text with an animation for turning the pages and an adaptation of the text size. Nevertheless, this dynamic formatting prevents an addressing to a certain book page what is often helpful in lessons. However, jumping to single chapters of the books is possible, searching functions and dictionaries are also integrated. The epub format enables to mark text or to add notes to text. Another advantage of the epub format is the possibility to integrate audio files or video clips in the ebook, which can be played directly in the ebook. A text from the ebook in epub format can be posted directly from the book to social networks like Twitter or Facebook, and can be sent also as email or SMS. Nevertheless, using these features the question about copyright laws arises.

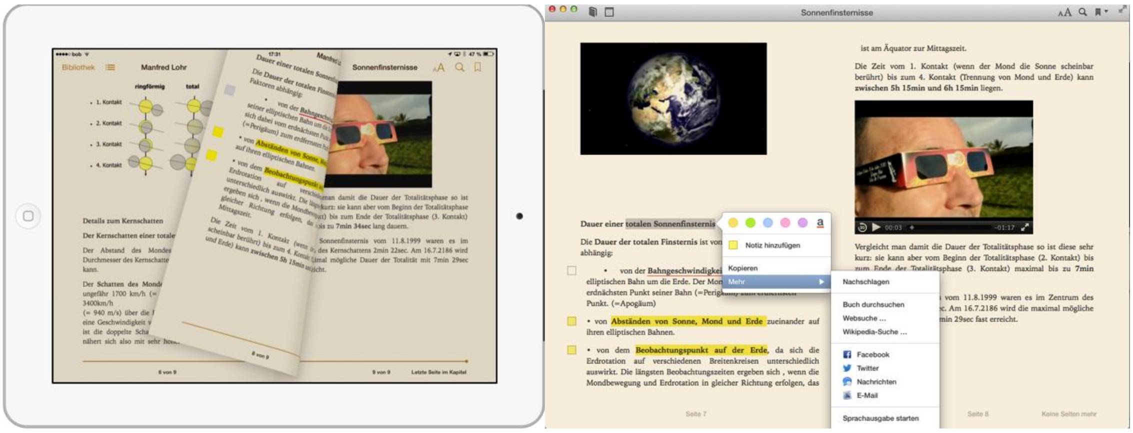

Figure 2. The epub format on iPad (left) and Mac PC (right)

The iBook format developed for Apple operating system enables to use multimedia contents and interactive elements in an ebook. In this format the author has the possibility to provide interactive pictures and 3D objects beside picture galleries and videos. Quizzes and multiple - choice questions of different types help to control the educational objectives. Access to dictionaries or encyclopaedia is built in, postings on Twitter and Facebook are possible in this format as well as the integration of diagrams, tables and mathematical formulas. Using the iBook format the author can install a glossary for example to define scientific terms, power point or keynote presentations can be viewed directly in the book.

2.3 Creation of ebooks – Investigation of Various Software

As no multimedia enhanced ebooks with content related to the curriculum of Physics are offered by Austrian schoolbook publishers this chapter deals with the creation of ebooks by a teacher without advanced programming knowledge. This study was done by the usage of Windows PCs compared to Mac OS PCs and iPads.

A simple way to design ebooks with a Windows PC is the free software Calibre, which enables the user to convert text files of some formats (for example word documents, pdf files) to the epub format. Unfortunately Calibre doesn't support any multimedia files, therefore it seems not suitable to create digital books following the user needs of teachers in science subjects.

However, the text processing program *Pages* which is available for the operating system Mac OS as well as for iOS on iPad and iPhone allows an easy export of text to the ePub format with the integration of audio and video files. *Pages* opens text files provided with Microsoft Word too; audio files and video clips simply can be dragged into the document, after exporting to the epub format these clips can be played directly during reading the ebook.

The usage of an iPad with iOS 7 enables to record audio files and videos clips directly with the device and to transfer them with one click to *Pages*. After the export of the document to the epub format the ebook is available in the application *ibooks* on the iPad or in another ebook reader application like for example *kindle*. This approach is also applicable for pupils to create digital books in order to present or to reflect a topic.

Another simple possibility to compile ebooks is the usage of the application *"Book Creator"* available for iPads, similar applications are also available for tablets running with the operating system Android.

In the framework of the described project pupils of the 4th class had to fulfil the task to produce a summary about some chapters of their physics curriculum with the help of the application *"Book Creator"*. This application offers similar possibilities like Pages with a little bit fewer formatting options. It was obvious that pupils were very motivated and engaged to provide an ebook with the use of iPads. During this task pupils learnt to reflect upon the chapters done and to present physical laws in short audio or video podcasts. They practiced to present scientific laws with creative tools on mobile devices.

After the creation of the ebook was finished the pupils opened their ebooks with the application *iBooks* and saw their results without delay. They sent their ebook to their private mobile devices and by doing this they created mobile content which motivated them to deal with scientific topics at home.

As final task in the activity described above pupils had to upload their ebook to the moodle platform where the teacher assessed and commented the ebooks of the pupils.

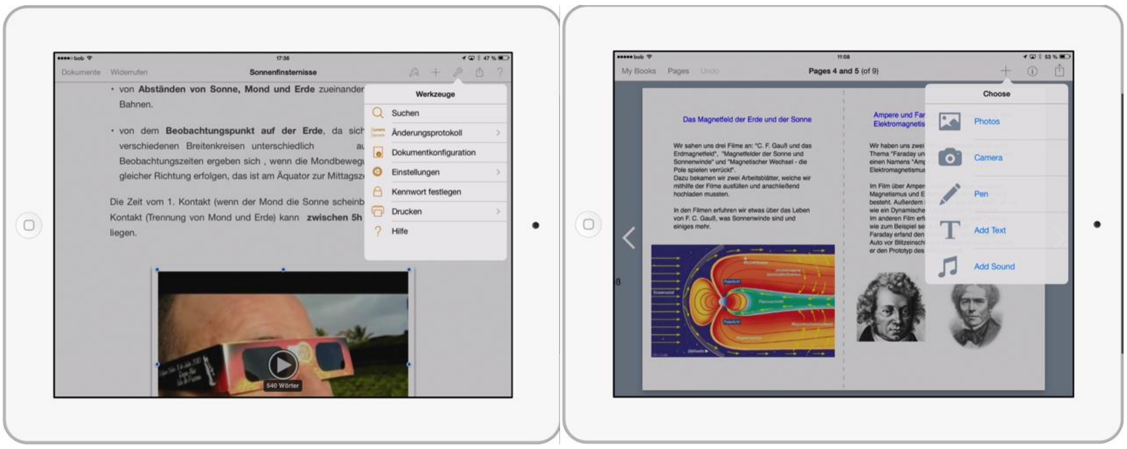

Figure 3. Creating ebooks on iPad with Pages (left) and Book Creator (right)

During the assessment of the ebooks by the teacher the need of opening digital books with a desktop PC became important. Apple PCs with the operating system mavericks 10.9 offer the program *ibooks* which presents the ebook with the same layout and features as on a mobile device (with the exception of the animation for changing pages): you can highlight and underline text, add comments to text, set bookmarks, use dictionaries, browse the internet and post to facebook or Twitter. (see Fig. 2. right picture)

In order to read an ebook given in the epub format with a Windows PC one can use for example the software Calibre or Adobe Digitally Editions; using these software text and hyperlinks are displayed very well, nevertheless, the reproduction of video and audio clips doesn’t work. Additional features which are available in the *ibooks* program are missing.

The present work continued to find out how to create ebooks of the next level, which means ebooks with interactive elements. The investigation of software for the creation of interactive ibooks started with the search for software for Windows PCs because this operating system is the standard in schools in Austria.

A short summarize of the result of the efforts is that there are only few programs available: a professional software available for Windows PCs to create ebooks with interactive elements is “*Adobe InDesign”*.

Demanding that the creation of ebooks should be possible without knowledge in programming and without a time-consuming procedure, “*InDesign”* is not suitable: this result was obtained after the software was tested by 2 teachers, who expressed the assessment that the usability of this software doesn’t meet the needs of teachers in producing ebooks.

The Mac operating system offers the free software *"iBooks Author"* which enables users with average knowledge in the work with PCs to produce impressive interactive ebooks: *“iBooks Author”* provides some precast layouts, the contents are moved by drag and drop to the ebook: thus not only interactive pictures, picture galleries and video clips are produced, but also 3D objects which can be taken for example from a collection of *SketchUp* objects available in the web or produced by the software *“SketchUp”*. Doing a few simple steps one can provide text with a scrollbar, produce popover texts and quizzes of different kinds. During the creation of the ibook the software *"iBooks Author"* provides a preview of the ibook at an iPad connected to the PC. *"iBooks Author"* is a programme which enables in intuitive manner to provide ebooks with various interactive elements.

As disadvantage must be marked that this program is available only for the operating system Mac OS. There are also some limitations regarding the output formats: *"iBooks Author"* offers as main output format the ibooks format, which unfortunately only can be displayed on iPads or iPhones, smartphones and tablet PCs with another operating system cannot open this format. Since September 2013 interactive ibooks created with *"iBooks Author"* can be read on Mac PCs using the operating system Mavericks 10.9. As second option *"iBooks Author"* allows the output as pdf format with the disadvantage of the loss of all interactive elements.

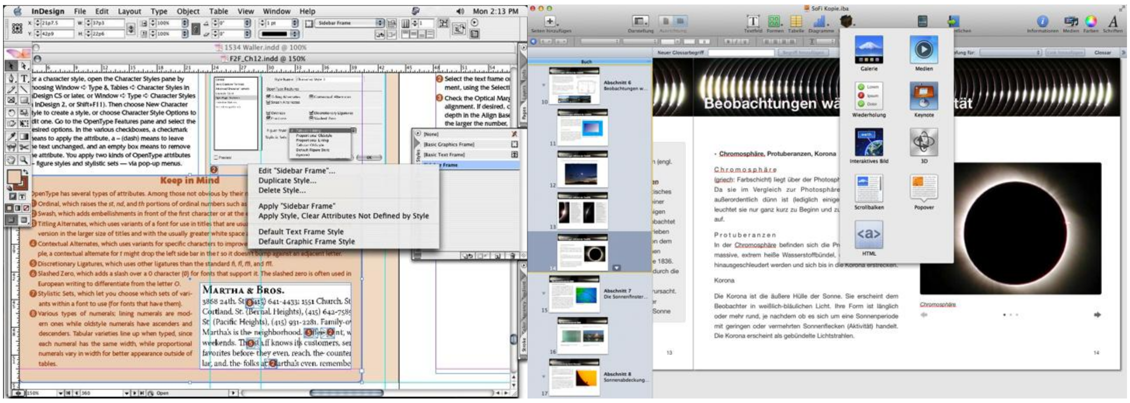

Figure 4. Adobe InDesgin (left) compared to iBooks Author (right)

2.4 Feedback of Pupils – Motivation and Advantages

The feedback of the pupils was collected with the anonymous feedback tool of moodle. Pupils completed a questionnaire with 5 categories for answering each question and some open questions with free comments.

Only by one quarter of the pupils preferred ebooks in pdf format instead of printed books for learning purposes, nevertheless, the vast majority of pupils rated the usage of iPads as very motivating.

The feedback of the pupils about books in epub format was clearly better: 62% totally agreed to work rather with ebooks in this format than with printed books. They mentioned the representation of the text with the animation to change pages as well as the integrated videos as motivating features of ebooks in the epub format, dictionaries and notifications were hardly used by pupils in this age group.

The observation of the engagement of the pupils during the lessons gave to the following significant result: pupils participated very engaged in solving their tasks with iPads and ebooks, the usage of these digitals devices and software tools caused a higher motivation than with teaching forms without these digital tools.

A clear increase of the positive feedback of the pupils appeared concerning the questions asked about the use of interactive ibooks: 81% strongly agreed to the statement to work rather with an ibook than with a normal book, only just 10% preferred normal books. Pupils had no difficulties to control ibooks with swipe gestures well known on their smartphones, the interactive elements were also properly used by almost all pupils without the need of any instructions of the teacher. Asked about their preferences in the field of tests pupils favoured the interactive quizzes instead of written tests. A majority of pupils stated that interactive pictures or 3D pictures helped them to improve their understandings of scientific content.

The vast majority of the pupils valued creating books with the application *"Book Creator"* very positively. 72% agreed that the use of the virtual keyboard of the iPad caused no problems, the creation of ebooks was valued almost by everybody as an important enrichment of the lessons.

69% stated that they have learnt better by this kind of repetition of syllabus than by other methods.

Other aspects of the use of ebooks on iPads are described very well by the following comment of a boy: „It would be great if we had all school books as ebooks – we could never forget books and wouldn't have to drag heavy schoolbags!"

3. CONCLUSION

The project has proved that learning and teaching with digital books in physics lessons helps and supports pupils to understand complicated scientific conceptions.

The comparison of the used ebook formats pointed out that ibooks with their numerous interactive elements are very suitably for scientific lessons in the age group of 13 and 14: the haptic interaction with the content ensures new learning experiences which are very important in view of competence-oriented learning in natural sciences. A better individualisation of lesson becomes possible because pupils can choose their own learning rate and can repeat interactive explanations as well as quizzes as often as they like.

Potentially the epub format has a bigger meaning for older pupils: they have a very easy access to scientific literature or can read free of charge many classics of the world literature on tablet PCs.

At the moment the creation of ebooks and ibooks for teachers with realistic effort is possible only with the usage of the operating system Mac OS and the software *Pages* for the epub format or with the software "*iBooks Author"* for the ibook format.

The experiences with the present project allow the conclusion that ebooks will have an important meaning in the school of the future. The author is highly confident that interactive ibooks have everything they need to perform as an excellent tool for (science) teaching. In the opinion of the author publishers of schoolbooks should start to make some efforts in order to provide interactive ebooks for the pupils of the school of tomorrow.

ACKNOWLEDGEMENT

An evaluation of the project "ebooks in physics education" was carried out at two levels: First, teachers participating in two e-lectures "Creation of interactive ebooks" of the author organised from the Virtual Pedagogical University of Austria had the opportunity to express their views on the usage of ebooks in science teaching, and secondly, as part of the "Tablet User Days 2013" at the Pedagogical University of Lower Austria the audience of the lecture "ibooks in science teaching" of the author gave their feedback.

Every teacher participating in the e-lectures saw the great potential in the use of interactive ibooks and developed ideas for the usage of ebooks in their subjects. The mobility of the iPads for blended learning sequences in the classroom avoiding the move of all pupils into the computer lab was highlighted.

The audience at the "Tablet User Days 2013" at the campus Melk of the Pedagogical University of Lower Austria had already gained some experience with iPads in the classroom. New to them, however, was the concept of the use of interactive ibooks as described above – this approach received a very positive feedback.

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MOBILE LEARNING AND EARLY AGE MATHEMATICS

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ABSTRACT

The ability to develop engaging simulations and constructive learning experiences using mobile devices is unprecedented, presenting a disruption in educational practices of historical proportions. In this paper we describe some of the unique virtues that mobile learning hold for early age mathematics education. In particular, we describe how object-based learning, any place / anywhere learning, collaborative learning, gamified learning, customized learning, and adaptive learning, come to play in our work on *SlateMath*. SlateMath is a richly indexed portfolio of hundreds of instructional units, designed to support the teaching and learning of mathematics at the elementary school level (kindergarten through sixth grade) using mobile devices. SlateMath is cross-platform, multi-lingual, and freely available for schools and teachers world-wide.

KEYWORDS

Mathematics education, tablets in education, mobile learning, adaptive learning.

1. INTRODUCTION

SlateMath is a large scale portfolio of immersive math education apps for tablets and personal computers. The minimal learning object in SlateMath is called *episode*: a bite-sized interactive progression of several related and increasingly challenging hands-on activities, presented in a playful and animated user experience. A typical interaction with a SlateMath episode lasts between ten to thirty minutes, and seeks to address a single, well-defined, curricular-driven mathematical concept, skill, or insight. In addition to these hands-on activities, SlateMath also features numerous interactive worksheets that last as long as it takes to complete the given problem sets.

The hands-on episodes focus on building an intuitive understanding of the subject matter, e.g. understanding, hands-on, the rationale behind the distributive rule a (b + c) = ab + ac; this is done via games and interactions that use graphical imaging to drive home the nature of the distributive rule and how it comes to play in solving algebraic problems. The worksheets, on the other hand, are designed to build a mastery of the related skill set, e.g. solving algebraic problems that involve different manifestations of the distributive rule. Both the episodes and the worksheets are adaptive, as we describe shortly.

The SlateMath portfolio is a structured collection of about 700 such episodes and worksheets, designed to support math education from kindergarten through sixth grade. The verb "support" is important. Unlike various instructional technology approaches that seek to replace traditional frontal teaching with on-line video lectures (Thompson, 2011), SlateMath is not intended to teach math, but rather to help teachers teach math. It provides an abundance of richly-indexed activities and exercises that can light up a lecture and turn a classroom into a lively math laboratory. Teachers normally use between one to three SlateMath episodes in each class meeting, in a blended fashion that alternates between frontal teaching and self-paced student practice.

Perhaps the biggest challenge in early-age math education is that children gradually develop math deficiencies that go unnoticed and uncorrected. These hidden deficiencies linger into the program, causing mounting frustration and accelerated incompetence. With SlateMath, the child's performance is continuously monitored. When the child's work indicates that he or she is remiss of some requisite skill, SlateMath prescribes remedial work, using relevant, pre-requisite episodes. This student diagnostics is carried out by the software continuously and in real-time, while the errors are still fresh and unsettled.

SlateMath comes with student authentication, tracking, and analytics capabilities. A teacher dashboard provides both on-line and periodical status reports about each student's performance. The system is cross-platform and multi-lingual, and is freely available to schools and teachers world-wide. The iOS version of SlateMath can be downloaded from the Apple app store, and an on-line web version is also available (www.slateMath.com). An Android version will be released soon.

The paper starts with a description of the SlateMath approach to math education. This sets the stage to a more general discussion of the virtues of mobile learning in early age math education.

2. EPISODE EXAMPLE

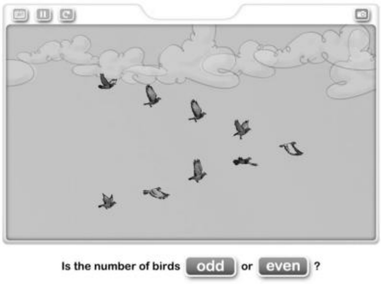
Much of early-age math education revolves around understanding and mastering the four basic mathematical operations: *addition*, *subtraction*, *multiplication*, and *division*. Every one of these operations entails an elaborate body of evolving knowledge, which is best acquired over a period of several years (Lee and Ginsburg, 2009, Kline, 1998). For example, according to the American math curriculum, also known as the *Common Core State Standard*, children should start being exposed to simple forms of division in grade 3. That said, nothing should prevent educators from sowing the seeds of understanding division much earlier in the program. To illustrate, one way to set the stage for understanding division is to introduce children to the notion of *parity*, and to the related concepts of *odd* and *even*. Parity is based on a simple form of division – division by two. This section describes a SlateMath episode designed to introduce the notion of parity in a hands-on, constructive fashion. We note in passing that there is nothing special about this particular episode, and we present it in order to introduce readers to the spirit of SlateMath-based learning.

How can you tell if a given number, say 28, is odd or even? The simplest way to go about it is to look at the number's rightmost digit; if it's divisible by two, the number is even; otherwise, it's odd. This rule works well, yet it provides no algebraic insight whatsoever about "being odd" or "being even" – a property commonly known in mathematics as *parity*. Importantly, our goal is not to just teach children how to tell if a given number is odd or even – we wish children to "feel" parity in a natural and constructive manner. With that in mind, SlateMath features a dedicated episode and a teaching guide that focus on solving parity questions using an interactive, hands-on "parity lab".

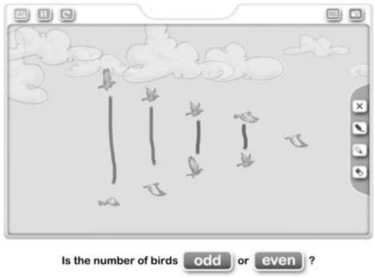
As the Figure 1 shows, the child is invited to play with different flocks of birds, each having a different formation and symmetry. The teacher explains that there are two ways to determine if the number of birds in a given flock is odd or even: we can either try to divide the birds into pairs, or we can try to partition them into two subsets containing an equal number of birds. If we succeed to do so, and no bird is left out of the division, we say that the number of birds in the flock is even. If one bird is left out of the division, we say that the number of birds is odd.

Using the touch user interface of mobile devices, the software encourages the child to rearrange the flock into pairs or into equal subsets, and observe how many birds were left out of the division. This hands-on manipulation, when applied to different flocks of birds, leads to many interesting mathematical insights. For example, we quickly discover that irrespective of how many birds a flock contains, either one bird is left out of the division, or no birds are left out. And, because the software encourages moving the birds around and rearranging them in groups, the child discovers that "being odd" or "being even" is not a property of individual birds, but rather a property of the entire flock. Some of these learned insights run deep. For example, by playing with certain flocks, children discover that the sum of two even numbers is always an even number, and that the sum of two odd numbers is, surprisingly, also an even number. They use these insights to reason about the parity of subsequent complex flock formations without having to count the birds. In short, the children are exposed not only to mathematical concepts, but also to how mathematicians think. Importantly, each SlateMath episode is accompanied by a teaching guide that suggests a set of activities, insights, and discussion points. For example, teachers are encouraged to point out that when we pair up any number of birds, the number of birds that are left out of the division is at most one. This plants the seeds for understanding the subsequent notions of a *remainder* and *modular arithmetic*.

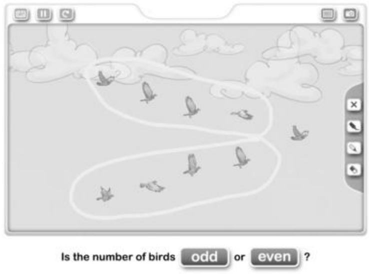
The parity episode is just one out of hundreds of episodes contained in SlateMath. This elaborate body of instructional materials, and the pedagogy behind it, constitute an approach to early-age math education that can be described as *object-based*, *mobile*, *collaborative*, *gamified*, *customized*, and *adaptive*. The rest of the paper describes each one of these virtues in some detail.



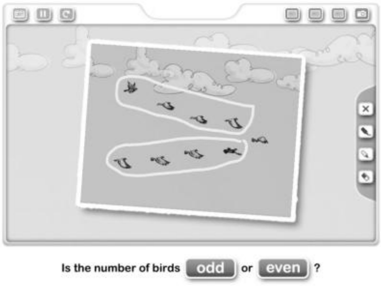
Is the number of birds odd or even? Can you answer the question without counting?



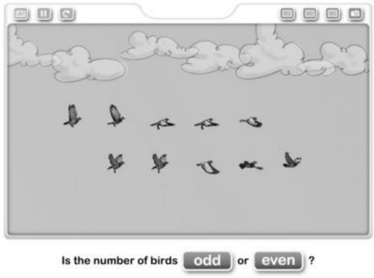
Using a retractable overlay screen and virtual crayons, we can arrange the birds in pairs. Note that one bird is left out.



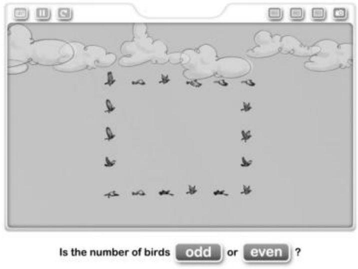
Creating two groups containing an equal number of birds. Once again, one bird is left out of the division.



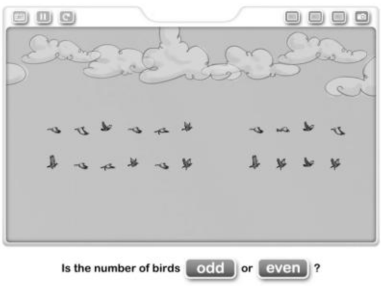
A camera tool can be used to take and save snapshots of one's work.



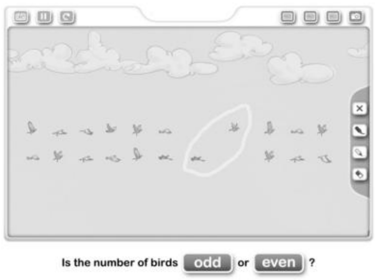
Another flock formation. The leading and trailing birds can be moved around, creating a pair.



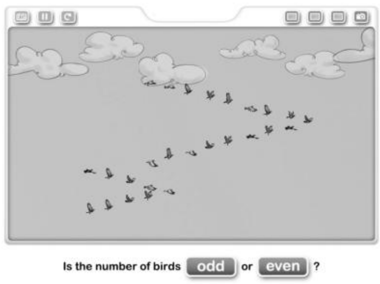
Another flock formation, out of many more flocks of varying symmetry.



We use this formation to reason that the sum of two even numbers is an even number.



We use this formation to reason that the sum of two odd numbers is also an even number.



Since the parity of a symmetric arrowhead is odd (top left example), and odd plus odd gives even (previous example), we conclude that the number of birds in this flock is even.

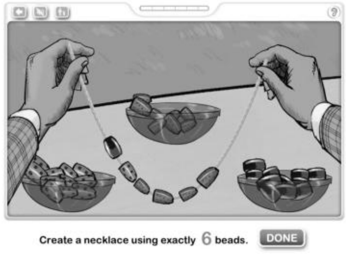
Figure 1: Screenshots from the parity episode. different flocks of birds fly into the screen; the task is to determine if the number of birds in each flock is odd or even. to do so, the child is encouraged to move the birds around and rearrange them in groups. this is done using a retractable and transparent overlay screen, a set of crayons, an eraser, and a camera – all software artifacts. (the figures are far more attractive in their original colors)

3. OBJECT-BASED LEARNING

We believe that early-age mathematical skills are best acquired through direct manipulation of familiar objects in familiar settings: counting animals, sorting cookie jars, cutting and pasting geometric figures, and so on. Indeed, child developmental psychologists, most notably Jean Piaget, observed that tactile manipulations of concrete objects help children form math concepts and operations using their own cognitive devices (Wadsworth,1996). This innate learning process can be significantly accelerated by teachers who can prepare, monitor, and guide such hands-on explorations in the classroom.

Unfortunately, it is unrealistic to expect teachers to arrange, and bring to the classroom, thousands of physical objects ranging from birds to beads to boats. Fortunately, mobile devices can come to the rescue. For example, our SlateMath software employs a state-of-art graphical user interface and a physics engine to simulate the manipulation of numerous familiar objects in an accurate and engaging manner. These guided interactions are carefully designed to facilitate hands-on exploration of math concepts and insights within a playful and supportive learning environment. Figure 2 gives some examples.

Counting, from objects to number:
How many fish do you see?
(when a fish is touched, it glows)



Counting, from number to objects:
Create a necklace using n beads.

Forward counting, over space:
how many elephants in the entire scene? (the scene continues, and can be scrolled, sideways)

Forward counting, over time:
How many birds flew over the roof?
(snapshot in mid action)

Speed counting:
How many meerkats did you spy?
(the meerkats pop in and out)

Addition episode: the next question is "*how many beads are in the necklace altogether*?"

Figure 2. Examples of some slatemath episodes that focus on different flavors of *counting*. the software features an optional voice-over channel that helps overcome reading difficulties. children answer the questions using three possible means: choosing numbers from a number wheel, using the keyboard, or writing the number on the screen, using a stylus or one's finger.

The impact of "touch interface" on learning has been studied by Ketamo (2002), Dede (2009), and Savila (2010), among others. Likewise, the importance of playing with "virtual manipulatives" (what we call "object-based learning") has been described by Reimer and Moyer (2005), Steen et al (2006), and Bolyard (2006). The judicious combination of these two modalities help us expose children to numerous real life yet simulated scenarios that involve mathematical reasoning, and to help them gain a hands-on understanding of the underlying mathematical concepts and techniques.

4. ANYWHERE / ANYPLACE LEARNING

The abundance of hardware and software platforms that characterizes today's mobile space is not a curse, but rather a blessing. This technological diversity provides the foundation on which competition thrives, incentivizing companies to constantly innovate and come up with better hardware platforms, operating systems, programming languages and software libraries. Thus, multi-platform is here to stay; instead of trying to ignore or undermine it, we recommend coping head-on with the challenges that it presents. Below is an example of one such a coping strategy.

Which tablets should our school adopt? iPads? Kindle Fires? Touch laptops? The desired answer should obviously be – use whatever devices are available in the classroom. Indeed, educators are increasingly embracing a BYOD, or *Bring Your Own Device* policy (Sharples et al, 2010): teachers and students should be encouraged to use different tablets and smartphones, sourced by schools, homes, governments, and philanthropists. For example, consider a teacher who wishes her students to use a SlateMath app to practice their math skills. The BYOD commitment requires that SlateMath will run as-is on all the mobile devices that happen to be present in the teacher's classroom, irrespective of make and operating system differences.

Cross-platform compatibility is also essential to support the increasingly popular any-time, any-place learning mode. Consider a student who has just used SlateMath on a school-supplied iPad. On her way home in the school bus, the intrigued student may wish to continue playing with SlateMath on her Android smartphone. And, once back at home, she may wish to switch to a larger screen, using a laptop that runs SlateMath in a web browser. The SlateMath app runs as-is on all these devices, giving the student a consistent and continuous user experience. The software operates exactly the same on each device for the simple reason that it is the same software running everywhere. And, as the student hops from one device to another, her academic performance and usage history are updated seamlessly on the cloud, feeding the teacher's dashboard.

The ability to execute the same code base on multiple devices and operating systems is made possible thanks to an elaborate cross-platform software architecture and authoring system. This architecture, which allows executing the same software in both browser and native code environments, will be described in a separate paper.

5. COLLABORATIVE LEARNING

When we started running pilots using SlateMath in classrooms, we noticed that many teachers preferred having two students interact with a single tablet, rather than using a one-to-one setting. At the beginning, we though that the two-to-one setting was chosen because of lack of tablets scarcity; as the year progressed, though, we realize that putting two children on one tablet has many virtues on educational grounds.

When two students use a single device, they must take turns: one student solves a problem, or interacts with a game stage. When the next problem or game stage starts, the second student takes over. This mode of interaction has three main benefits. First, it teaches patience and delayed gratification. Second, the "passive" child can observe the work of the "active" child and reflect on the educational contents without the pressure of actual interaction. Third, in many cases, the "passive" child acts like a guide, helping the other child with tips and advice. Taken together, all these behavioral patterns contribute greatly to the development of critically important social skills.

When it comes to sharing, tablets have a significant tactile advantage over laptops. Since they lie flat on the table's top, they can be easily swiveled from one side to another. As a result, several children can share the same device without having to move from the chairs.

6. GAMIFIED LEARNING

For many children and adults alike, desktop and laptop computers symbolize "work", whereas tablets symbolize "play". Indeed, developers who build tablet software strive to create a fresh and engaging user experience. The GUI, terminology, and "lore" of tablet software draw heavily from the world of gaming.

Indeed, "gamification" is a hugely important concept in tablet software, as many developers use gaming ideas to make learning more fun and addictive (Kapp, 2012).

That said, as educators, we must make sure that the gamification will not compromise our educational mission. For example, many math teaching programs and textbooks sugarcoat the "boring math" with gamification elements like number-eating cows and similar contraptions, each following one developer's fantasy on the best way to explain some mathematical subject. We don't believe in number-eating cows, for two reasons. First, cows don't eat numbers. Second, math is sufficiently attractive in its own right, and there is no need to decorate it with infantile metaphors. Our experience shows that SlateMath endears math on children as young as 4 year-olds by helping them master common tasks that unfold in common settings: counting animals, hanging balloons, decorating cakes, and so on. There is no need to have a dinosaur slap its tail on the smaller of two numbers when there are many interesting ordinary scenarios in which order comparisons come to play. Moreover, identifying which mathematical procedures are applicable to which everyday situations is in itself an important math literacy skill.

We do gamify the SlateMath working environment with peripheral motivators like avatars, badges, and a quest-like context. And yet, although we want children to feel engaged and rewarded, we don't believe in shortcuts and instant learning. Analytic reasoning, like any worthwhile intellectual art, takes time to develop in one's mind. Therefore, we want the magic of math to grow on children gradually, as they complete more SlateMath episodes and become increasingly more competent and confident in their work.

7. CUSTOMIZED LEARNING

Individual SlateMath episodes are short and self-contained. Each year in the K-6 math program is supported by a portfolio of about 120 SlateMath episodes. Each one of these episodes entails a series of related tasks, resulting in thousands of different interactive activities.

The resulting SlateMath portfolio is highly modular, richly indexed, and recombinant. Every week, teachers select the SlateMath episodes that best support their weekly teaching program, and assemble them into a customized, weekly math learning bundle (we provide default weekly bundles, designed to cover the entire year). This way, teachers control the selection and order in which the episodes become available to their students. And, in a BYOD (Bring Your Own Device) setting, teachers can control the episodes availability and staging outside school as well. All these tasks are done through drag-and-drop operations on the teacher's dashboard.

The pre-determined contents of the weekly math bundle can be easily overridden. If the teacher feels that the class dynamics requires access to additional SlateMath episodes, he or she can easily make them available to the students. Episode selection is done by queries like "I need episodes that practice ordering objects according to their length" or "I need episodes that support the Common Core 1.MD.2 topic". Once again, all these tasks are done on the teacher's dashboard.

8. ADAPTIVE LEARNING

When serving an episode that requires adding up integers, SlateMath can detect that the child's counting skills are not sufficiently developed; when serving an episode that involves fraction arithmetic, SlateMath can detect that the child has trouble computing common denominators; when serving an episode that involves calculating triangle areas using geometric manipulations, SlateMath can detect that the child does not know how to calculate rectangular areas. SlateMath continuously monitors the child's actions in each episode, and accumulates reams of data about the child's evolving math abilities. Importantly, this continuous monitoring is done in vivo, while the child interacts with the actual episodes, rather than in subsequent and out of context quizzes. The latter check if the child can pass math exams; the former check if the child understands math.

The diagnostic data that SlateMath collects is continuously mined, summarized, and presented on the teacher's dashboard. Teachers can get real-time information about each child's current performance, as well as tallied information about the child's cumulative progress. If the child's work indicates that he or she is remiss of some math topic, SlateMath recommends remedial action, using relevant episodes. The teacher can either accept these recommendations, or modify them to come up with another corrective procedure.

The fact that different children learn in different paces is one of the biggest challenges in mathematics education. In less tightly layered fields of study, missing a class or a concept can be easily rectified, or even side-stepped. Yet in math, if children fail to grasp the notion of a common denominator, they will be at loss when learning fraction arithmetic. They may be able to solve equations, following supplied algorithms, but they will not understand why the algorithms work. Such are the early fault lines from which math anxiety begins to emerge, setting the stage for a life-long math phobia that typically takes hold sometimes between elementary and middle school.

9. CONCLUSION

In the era of tablets and smart phones, learning can occur anytime, anyplace. That said, we believe that no technology can replace human touch, especially in early-age math education. In particular, the teacher's role in staging and guiding the learning process is indispensible. That's why SlateMath does not pretend to teach math, but rather to help teachers teach math.

According to Bertrand Russel, "Mathematics, rightly viewed, possesses not only truth, but supreme beauty — sublimely pure, and capable of a stern perfection such as only the greatest art can show." With that in mind, our goal is not limited to developing reasoning skills and math literacy. We are equally interested to endear math on children, and to kindle an affinity to quantitative reasoning and to science in general. Math proficiency provides a foundation for becoming a rational, productive, and self-reliant person, and opens numerous career possibilities; helping children build this foundation is our overriding passion and commitment. We feel fortunate that tablets enable us to fulfill this mission with unprecedented effectiveness.

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M-LEARNING – ON PATH TO INTEGRATION WITH ORGANISATION SYSTEMS

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ABSTRACT

Learning is essential in organizations for them to survive. However, given the changing environment owing to global inter-connectedness, mobile workforce, global unpredictability and complexities, the learning approach must also change. Today the Learning and Development unit must be able to facilitate collaborative work, develop learning practices in tune with the trends, and bring in appropriate tools and processes. Elearning systems may not suffice on their own owing to the need for infrastructure resources and the location dependency. Mobile Learning would help resolve several of these issues and can be used for various applications such as recorded information, audio files, reading, learning applications, scheduling, calendar features, assessments, collaboration, support and co-ordination activities, amongst other functions. However, for m-learning to be effective, the learning delivered must be recognized and credited, with learning being mapped to competencies database and roles assignment. Hence, the m-learning must be integrated through the LMS to competency management systems, internal knowledge management system and the collaboration network to benefit from peer learning. The case of an Academy in an IT major is described in this regard. The Academy, despite its success, is now piloting its mobile platform. For sustained usage of mlearning globally, there are challenges of device design, durability and network issues that need to be addressed.

KEYWORDS

Learning, mobile, elearning mlearning, integration, blended learning.

1. INTRODUCTION

Learning has been an important tool in devising business and competitive strategies. Intimate knowledge leads to innovation, which again leads to better products and services and happier customers. At all levels, learning is a critical enabling function for a competitive organization seeking to consolidate its growth. Today's environment is marked with global complexities, inter-connectedness and unpredictability and the changing nature of the work force. Work and learn constantly is the mantra, with both being continuous to keep pace with changes. In this new world order, learning systems must perform three core functions – i) Facilitating collaborative work; ii) Sensing trends and helping to develop learning practices; and iii) Working with management to bring in appropriate tools and processes. The existing learning systems focusing on traditional classroom training may not be able to offer these features. Learning departments in most organizations are aware of this shortfall and are implementing elearning platforms. In 2012 alone, corporate training was a $200 billion industry. ELearning represented $56 billion of that and is expected to double by 2015. The LMS (Learning Management Systems) market alone is likely to grow to nearly $2 billion in 2013. E-learning on its own may not address the requirements of the globally mobile workforce, given the location specific constraint it poses. M-learning would be good option due to multiple factors such as its location independence, absence of need for heavy duty resources, and employee comfort factor. The paper lists several applications possible through m-learning. Also, the paper suggests that m-learning application be integrated with existing learning management system and through it also be integrated with key systems in the organization including the competency system, knowledge management system and the social collaboration network internal to the organization. Recognition and certification are also key to m-learning success. The paper also gives a case study of an Academy in an IT major that focuses on business domain learning through technology.

2. THE MOVEMENT TOWARDS M-LEARNING

Technologies today support the development of educational content that is more mobile and personalized, supporting the change of learning forms to elearning, mlearning and ulearning (ubiquitous learning). Mobile learning or m-learning as its called, is considered to be the most effective among flexible learning options, the reason is that it overcomes the limitation of a teaching location and location specific PCs. The additional benefit is that mobile learning utilizes the learner’s spare time from any place any time. Studies show that about 88% of US workforce says they use tablet in transit! Further, in large organizations, its hard to direct learning to the thousands of employees even through elearning due to the following challenges:

- **Personalisation** – despite interactive features, elearning suffers from a lack of personal touch.
- **Resources** – elearning requires additional resources from the company such as a PC or laptop, internet connection, maintenance and helpdesk issues and manpower requirements
- **Others** – Bulky laptops for mobile workforce, late boot up issues, lack of comfort

The resources aspect becomes a major challenge, particularly in large IT companies that have to deal with “the bench”. This means a big share of revolving pool of qualified graduates who fall into any one of the following categories: i)New joinees not tagged to any project and waiting for some allocation; ii)Professionals in between two projects and waiting to join soon; iii)Experienced professionals seeking completely new area and waiting for new projects. Most times, organizations are unable to provide them with computing resources due to non-availability of space, systems or simply due to security reasons.

To further compound these issues, the work force today is mobile, constantly on the move. Traditional effective though, would be irrelevant. E-learning through traditional devices such may not always be ideal. Hence, organizations are coming up with the concept called “Bring Your Own Device (BYOD)”, wherein employees can get their mobile devices to offices, after clearing security protocols. Employees then would be able to download official applications on these devices to conduct official activity. This highlights the fact that mobile devices are already gaining acceptance in organizations, especially in the IT sector. For example, an IT major has downloadable mobile applications in certain specific areas such as performance management, project attendance, leave management etc. Hence, there can be a case of extensive deployment of m-learning in organizations as they already are working with these devices. But mobile learning is gaining traction. There are several statistics that speak volumes in this respect.

- According to American Ambient Insight Report 2011, 39% of organizations were using mlearning.
- Mobile Learning Market to reach $9.1 billion by 2015 as opposed to the worldwide market for Mobile Learning products and services of $3.2 Billion in 2010. (Ambient Insight Mobile Learning Market Forecast 2009-2014)”
- According to IDC, about 75% of the US workforce is already mobile, with the numbers growing to 1.3 billion in 2015 or a massive 37.2% of global workforce.”

3. THE KEY ATTRIBUTES OF MOBILE LEARNING

The learning community and researchers have always opined that learning must be ubiquitous. There are certain attributes of m-learning as identified by researchers that support their use in corporate training field:

- Ability to function in formal and informal learning settings
- Communication intense medium enabling greater peer to peer as well as trainer-learner interaction
- Focuses on individual learning while promoting collaborative learning
- Learners using mlearning can use and also develop information individually as well as collectively

In a team environment, the collective learning feature of mlearning has the potential to bring down learning barriers and encourage development of solutions pertinent to the teams. Several research and piloting initiatives have revealed that ownership of mobile devices promoted involved learning.

The key features afforded by mobile learning are summarized the pyramid structure given below in Figure 1:

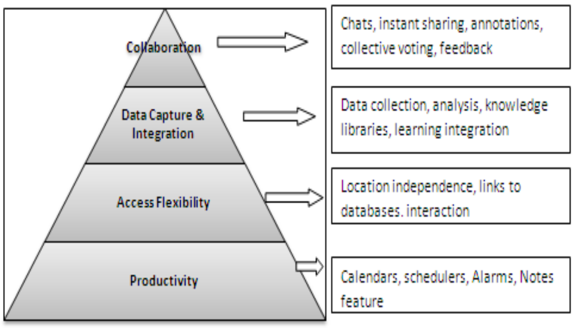

Figure 1. Features Afforded by Mobile Learning

Each level of this pyramid has application for mlearning in a corporate environment, as shown in the figure. The applications range from productivity, which aims to improve the learning attendance and absorption through several features to collaboration, which is highly reliant on communication. Thanks to these features, several benefits accrue to learning with mobile devices:

- "Individual" Learning – Learning driven by learner requirements in a suitable format
- "Timely" Learning – Flexible, convenient, fast track and completely relevant learning when needed
- "Adequate" learning - Highly applied, easily digestible learning for increasingly busy executives

4. TYPES OF MOBILE LEARNINGS THAT CAN BE FACILITATED

Mobile learning is not an ideal option for stand-alone learning vehicle, despite all the benefits given above. The major limitation is the absence of a validated, accepted industry framework for instructional design and delivery on the mobile device. Another major hurdle is the "noise" involved in mobile learning. Hence, in combination with other learning systems, m-learning can happen in following ways:

- Mobile learning in conjunction with elearning
- Connected classroom training
- Informal mobile learning in a social setting
- Mobile performance/training support

For all of these learning options, m-learning can facilitate different types of learning:

- **Recorded information/sessions** – Learners can input information through multiple ways and also record their observations, examples and thoughts in notes. These can be used to assist them in future for comprehension or assessments
- **Assessment** – Multiple types of assessments can be done. Trainers can do a small pre-assessment test so learners understand their progress. Final assessments can also happen on mobile devices.
- **Images** – Sometimes images speak louder than words. M-learning can include illustrations, photos, videos or even animations to explain concepts.
- **Collaboration via SMS, chat, networking, discussion forums and email** – Learners can communicate and share knowledge with co-learners and also the trainers/faculty.
- **Games/simulations** – There can be learning oriented games, simulations or other interactive features.
- **Compressed reading material – learning capsules** – Learning can be delivered as small reading files or anectodes or examples for reading.
- **Audio files** – Learners can listen to audio including short lectures, podcasts, research discussions and interviews, among others.
- **Polling/surveys** – This can be used for evaluations (such as asking learners to respond to questions). There are several other ways polling can be used. Learners can access the polling site from their mobiles to create surveys.

- **Search facility** – The internet on mobiles can be used to search for relevant information when needed.
- **Scheduling** – Calendar and scheduling features allow learners to organize their learning schedules, while also facilitating reminders, deadline tracking. It allows trainers to keep tab of attendance, performance and progress of learners.
- **Support and co-ordination** - Learners can store relevant messages and information and co-ordinate with trainers about course timetables, and content. They can engage in course reviews with their co-learnings and facilitate discussions.
- **Apps** – Smartphones today carry hundreds of applications that can help drive learning such as dictionaries, glossaries, calculators and several more.

5. THE MOBILE LEARNING ECO-SPHERE

The existing learning systems must be leveraged to employ mobile learning so learners can choose from a range of platforms. We propose a blended learning approach for integrating mobile learning with the organizational learning management system. According to one recent study, nearly 70% of the respondents cited mobile learning as an essential component for their learning management system (as per Parry, Carl. "eLearning Trends: How Hot Is Mobile Learning In 2012?"). Hence, most existing LMS platforms already have the required plug ins to support m-learning.

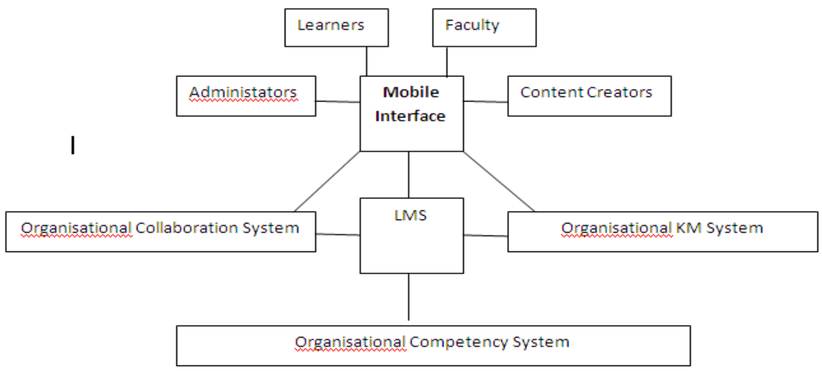

Figure 2. M-Learning Integration

M-learning is integrated with the internal learning management system. We suggested that all learning that happens is also integrated with the following systems – i) internal competency management system ii)the organizational knowledge management system iii) organizational social collaboration network

5.1 Integration with Competency Management System

In the corporate environment, learning is driven with one main intent, though there are several more intrinsic motivations – to gain the skill or competency required to perform and progress in the company. The organization also encourages this kind of learning to gain a pool of experts who can contribute to organizational growth. As such, as learning activities and recorded and mapped to a particular skill level. This motivates learners. For example, in one IT major, all learning is recorded by learning officers and then recorded in an integrated competency management system – manually if its classroom sessions or automatic in case of web based learning. By doing this, the company can check and see which employees have the competencies required for a particular project and call upon their services. Hence, it is good learning sense to integrate m-learning with the company's competency management system, which is again linked with the company's performance management system.

5.2 Integration with Knowledge Management System

An organisation's knowledge management system is a repertoire of all knowledge centric initiatives and activities. Learning with mobile devices form an important constituent of knowledge base. All m-learning initiatives have to be integrated with the KM system, as it is an important repository and available across the organization. It also helps linkages with project information repositories.

5.3 Integration with Organisational Social Network

The Gen Y employees are the most comfortable with social networking. Social learning does not simply imply learning via Facebook or Twitter (though these can be effective informal learning mechanisms), it includes a horde of other options such as blogs, wikis, discussion groups and search mechanisms for specific information. These can be part of the organizational learning platform and also integrated with mlearning. Social collaboration through m-learning is ideal in situations where learning on the job is required or where situational learning is needed. For example, an IT task which is not familiar to the employee or a client query for which the employee has no ready information. In such instances, the employee may refer the social platform for advice. According to the GlobalWebIndex Study 2013, usage of global social platforms is growing worldwide with mobile being the key driver. Other statistics point towards the growing influence of social media. Facebook has more than 1 billion users, of which 200 million are purely mobile based, which means a fifth of these users do not use PCs. Between 2010 and 2011, there was a 200% growth in mobile users accessing Facebook via their mobile devices. The number of Facebook users is nearly three times the population of the United States. This shows the extent of globalization that has occurred in the internet age. The learning departments can utilize this reach of social media and link m-learning with this media to enable more collaborative learning.

Once the m-learning platform integration is in place, there is a need for standardization across the organization to give greater leverage to m-learning system. The learning gained through mobile device needs to be recognized and awarded, which is what every learner seeks. The recognition thus obtained would gain organisation wide credence due to the integration as proposed in this paper.

6. LINK WITH CERTIFICATION STRATEGY

To ensure broadbased acceptance and implementation of m-learning, its content, formats and assessments should all converge towards a solid structure – certification and competency. Every role in any IT major requires certain competencies and these are mapped to the learning programs. M-learning supports these programs. To ensure that these competencies are recognized and follow a structure, how to evaluate these competencies? That's where certifications at various levels make sense. A certification carries some weight and can be related to a competency. This is easier than combining multiple sessions and trainings and assigning some competency.

With certification, the process is easy. The employee simply needs to complete the program, get a certificate and get mapped to a competency and then a role. So, the m-learning content and delivery needs to be linked to a certification strategy. Learning should be captured in the LMS that m-learning is integrated with.

7. CASE OF ACADEMY IN AN IT MAJOR

The training needs of a large multi-national IT organizational are highly complex. Apart from the obvious technology skills, employees need training in client vertical – both are highly dynamic sectors with rapid changes. Large companies know that learning is an asset and a continuous, life-long process. This is being driven by "client orientation" and the race to deliver more than expected to the clients to retain their competitive edge and maintain client relationships for continuous business. To add to the training complexity, large IT multinationals are active in several business streams such as software development, maintenance, services, product, BPO/KPO, and consulting. Accordingly, there can be several content areas that associates are trained on apart from technology, including Product, Management & Leadership, Process (quality, risk, security, compliance, HSE, etc), Functions (Marketing, sales, HR, finance, etc), Business domain, Softskills (Etiquette, Culture, Communication etc), Language and culture initiatives.

In this case of a Business Domain Academy in a large IT major, a study revealed that clients' satisfaction was low in terms business knowledge of people assigned to work with them. IT employees need intimate client vertical knowledge, processes and interactions, if they need to function effectively in any IT project including software development, a new solution, updation of an existing solution and even maintenance. Hence clients increasingly seek proof of business domain/vertical knowledge being imparted to IT employees and this has become a criteria for awarding projects. On the other hand, IT companies also seek this knowledge to gain a pool of subject matter experts who can help impress clients and bring out innovative solutions.

In the past, the IT major concentrated primarily on technology training, and with changing environment realized the need for focused, standard business domain training. Hence, there were initiatives at each industry vertical level– but suffered from duplication and a lack of structure and recognition. With this background, the IT major realized that traditional learning would not suffice and set up the Business Domain Academy as an online platform focusing on client vertical knowledge delivery. Apart from the global reach, the e-learning Academy was envisaged for several other benefits including – ability to scale up capacity, replicable standards, certification strategy, modular method for adding programs, report generation capabilities, operational efficiency, access control, easy database creation and maintenance, feedback mechanisms and discussion capabilities.

7.1 Expansion of the Academy

The Academy piloted its elearning system with banking and financial services (BFS) vertical and was widely accepted by employees and clients. The Academy soon followed up with non-BFS programs across other verticals such as insurance, healthcare, lifesciences, telecom, travel, hospitality, retail management, manufacturing, Media, Government, etc. The advantage was that the programs were free, and company copyrighted and filled a huge gap in learning function. Today, this Academy is central to all business domain activities in the company and are even contributing in sales and customer activities. The Academy initiatives can be clubbed in the main categories of: Online Certification Programs; Customized Training Programs; Train the Trainer Programs; Portal Management and Innovation; Research Activities, Pre-Sales Activities, Consulting and Content Development. Today the Academy has close to 140 certification programs across the verticals, more than 120,000 registered users, more than 27,000 certified in 2012-13, with 20% annual growth.

7.2 Technology and Standards

In terms of technology, the Academy adopted the Modular Object-Oriented Dynamic Learning Environment (MOODLE) as the core Learning Management System (LMS) with customizations such as registration page with CAPTCHA, negative marking for incorrect responses to quizzes, sequential order of learning, mandated feedback survey, automatic certificate generation (linked to fulfillment of survey), 90 days enrolment period. To facilitate easy upgradation and replication of courseware, the Academy has established standards for how the course is created, displayed and how learners are assessed, graded and certified. Course content is in the form of extensive word document and a presentation. Each program is grouped into modules (with 3-4 chapters in each module), with module wise quizzes and a final quiz. Quizzes carry randomly generated questions and negative marking for wrongly marked questions. Pass percentage is set at 60%. These standards ensure that the Academy is taken seriously and the effort put in by employees is recognized through internal recognition points as well as in terms of better projects and career path prospects. The Academy has over 120,000 employees registered with it!

7.3 Integration with Organisational Systems

The Academy is integrated with other key systems in the company - the competency and proficiency mapping tool, and the knowledge management system. All the three systems are integrated, so that the IT major can have a ready pool of skilled employees, who can be easily tracked, monitored and put into suitable roles. The Academy builds the base level business skills and knowledge through various tools such as e-learning, and integrated learning using the web-audio-video systems in sync. These skills get reflected in the competency system, which gives the learning roadmap, while creating a database of skillsets in the company. Often, material from the competency management system is linked to specific project repository on the KM system, so that projects can directly access the information required by them. The KM system directly links to the Academy portal, so that employees can look up and enroll into certifications of their domain. Also, whenever an associate completes a program in Academy portal, it gets updated in the competency management system. Thus, employees are able to get the best from all the systems and gain the maximum information and knowledge.

7.4 On Path to mLearning

Academy wants to reach out to greater Gen Y crowd through m-learning. The basis of this decision were a series of internal surveys among employees globally, conducted to understand behavior of employees with respect to mobile devices. Questions raised were i)the kind of device they use ii) applications they access over the device iii) Frequency of usage of device for such applications iv)Interest for learning over devices. Results showed that 48.7% had android phones, and 22% or over 61,000 employees lean towards mlearning. Another 21% or about 60,000 find laptop convenient and can be a future base. The organization also went social with the idea of mobile learning to monitor acceptance. Academy found that reaching out to this crowd enhance learning participation, as Gen Y comprises 73% of total workforce.

For this purpose, the Academy is integrating with the Moodle Mobile application for Moodle. This involved customization of the Academy page, and using the presentation for content rather than the word document, course history and status updates information,. In addition, the Academy would be part of the BYOD initiatives, with downloadable applications with regard to content and certificates. The pilot effort is on and the learnings from it would help further fine tune the effort. The current architecture of the Academy is given in the picture below with the mobile interface:

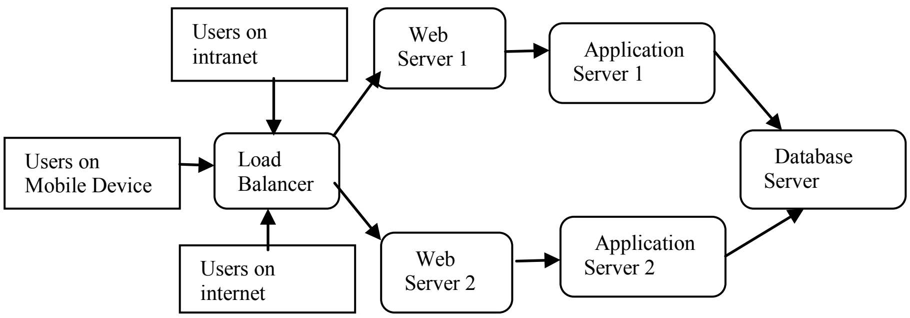

Figure 3. Academy Architecture

8. CONCLUSION

There are several merits to mlearning, but there are certain challenges too. If these are addressed, then the effectiveness of mlearning will grow multifold. The challenges are summarized below:

- The physical features of mobile devices may make learning deployment a challenge. The mobile device suffers from issues of small screen size, restricted memory and battery life constraints.
- There could be challenges with deployment and employment of learning applications on the mobile. The user while comfortable with communication and collaboration applications, may not be open to using the device for learning due to content issues, difficulty in adding the applications and lack of interest altogether.
- The obvious network speed and reliability concerns
- Physical environment related concerns such as outdoor visibility of the device screen, screen resolution, device radiations concerns, inability to use in case of rains

These challenges need to be considered when selecting mobile devices and developing learning platforms and content. For challenges relating to screen size, the content must be delivered as learning capsules, so that it overcomes the issue of extensive reading material in small screens. Given the lack of standard formats in terms of m-learning content and delivery, there is need for further work and collaboration among researchers and users to develop the same. Network operators are already coming up with high speed internet access, but there is need for widespread spread of such access and reliability options. In terms of the device sturdiness, there are weather proof devices coming up, but they are very expensive and there is scope for research in developing such devices.

While the paper suggests integration of m-learning with organization wide systems, there would be need for analysis and surveys internally in terms of acceptance of this change. Issues such as access control to such systems and the level of integration, plus modifying existing legacy applications to link them to m-learning and LMS need to be addressed. In terms of the kind of applications that can be put for m-learning, internal feasibility and acceptability again needs to be studied. This may vary from organization to organization.

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IMPROVING HISTORY LEARNING THROUGH CULTURAL HERITAGE, LOCAL HISTORY AND TECHNOLOGY

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ABSTRACT

History learning is many times considered dull and demotivating by young students. Probably this is due because the learning process is disconnected from these students' reality and experience. One possible way to overcome this state of matters is to use technology like mobile devices with georeferencing software and local history and heritage sources in a collaborative experimental approach to learning historical concepts of the traditional curriculum. This paper describes a study that has been done with a classroom of 7th graders in the scope of the History discipline and that combines the mentioned ingredients to foster history learning and interest.

KEYWORDS

History learning, Local heritage, discovery learning, collaborative learning, smartphones, GPS.

1. INTRODUCTION

The study of Heritage in local context values History as a learning living source, facilitates the understanding of historical concepts and helps to understand the world in which we live, contributing to the multiple understanding of history and to the building of the three pillars of history education: History - Memory - Identity.

Cultural assets and heritage are therefore pedagogically important as they are significant consolidation and implementation learning means that make teaching less bookish and more alive, giving meaning to learning too (Mendes, 2009).

Studying heritage and local and/or regional history is central to history learning and to the introduction to students to the discipline methodology and specific language – it is motivating, increasing the interest in history learning, integrator, because it contributes to the placement of the students in the environment they live in, and, in that sense, reinforces aspects of identity building, and it facilitates the understanding of history as a dynamic process in which knowledge appears not as being imposed, but making sense in a network of connections that are established between information, sources, testimonials and a narrative.

On the other side of the question, combining history teaching with technological tools and multimedia runs into the motivation of the majority of the "digital-born" for whom the screen is the most natural way to learn, communicate, play and interact (Moura, 2008, p. 142), taking advantage of students' potential and approaching the school and the teaching practice to the daily practice of this generation, familiar with the Internet and the constantly updating of technology. Simultaneously, it is a way to provide the same opportunities to all students and fight the digital divide.

"It is the quality of teacher education programs that is the key issue to a successful integration of ICT into the classroom and depends on the ability of teachers to structure the learning environment in non-traditional ways, to merge new technology with new pedagogy, to develop socially active classrooms, encouraging cooperative interaction, collaborative learning, and group work". (UNESCO, 2010).

The main aim of this work was to develop a way that prioritizes research methods, discovery learning and problem solving, motivating students to the understanding of the local environment and valuing them as active learners, showing also the possibilities and pedagogical advantages of approaching 7th grade History contents in conjunction with Heritage and Local History and using innovative and recent tools and technological applications in the areas of e-learning, Digital Culture and Historical and Geographical Information Systems.

2. MOBILE DEVICES AND GEOREFERENCED APPROACHES IN EDUCATION/HISTORY

Mobile technology is a resource with great potential to be used both in teaching and learning.

Its characteristics of mobility, portability and interactivity, ease of use, low cost, multiple and varied functions (like communication, taking pictures, recording, geographical orientation, etc.) bring great advantages (and challenges) to the process of teaching and learning: it eases experimental learning, it enhances collaborative work and makes knowledge more accessible, personalized and adapted to each one's rhythm.

Also the use of mobile technology with activities of georeferencing (Global Positioning System (GPS) and mobile phones / smartphones) has been done in education. Among the many experiences we can find, we can refer the "Projecto GO: Mobility in education", in the areas of History and of Heritage and Natural History contemplates the "development of historical, cultural and environmental pathways for Web global positioning systems" and the sharing of "information in the Internet as part of promotional activities of the local environment (in cooperation with the surrounding community) and national and international exchange projects" (CCEMS, 2008).

Also the project SchoolSenses@Internet uses geo-referenced multisensory applications developed by and for Portuguese students and teachers from the 1st cycle of education, as a strategy to improve the quality of elementary school education (Marcelino, et al, 2007). Through active practices that enable the analysis of complex dynamical systems, as well as the acquisition and sharing of knowledge, skills such as understanding, reasoning, reflection and creativity are developed with very positive results on the cognitive development of children.

These and similar applications enable interaction and the introduction of multimedia content, along with georeferencing, and that became pedagogical tools with unquestionable advantages: they allow the accomplishment of tasks through physical actions in the local environment, they encourage a greater participation and reflection ("enable children to reflect on what They are Currently engaged in", Druin, 2009) and they favor the development of diverse, but efficient forms of management and sharing of information. The ease of use and the friendly interface stimulate students' performance, capturing their attention and developing their autonomy, as they can be used in the construction of new knowledge, in the perspective of a collaborative and interactive learning.

Some other experiences of m-leaning corroborate the mentioned potential, namely:

- A greater collaboration among peers;

- Better results were achieved, but above all, the quality of learning was considered better: the learning process was more attractive, students felt more motivated and active participants in the construction of learning;

- Also the sense of belonging and identification were increased by the participation in "*virtual communities*" that overcomes age and cultural barriers" (Moura, 2008)

In conclusion, with Druin – "bridges can be built with mobile technologies that transcend differences in age, race, religion, nationality and culture which are worth significant investment" (Druin, 2009, p. 331).

3. THE PROJECT

The project consisted of developing a historical georeferenced route, called the Castle Route, working collaboratively with a first group of students in the class, completing the route with the whole class after and later editing and displaying it on Google Earth (GE), in a knowledge consolidation phase.

"The representations and interfaces for geographic information are seen as tools to make it possible: the link between real experiences and virtual experiences; travel between macro and micro worlds, between global and local contexts, understanding and sharing of experiences and environments and local identity" (Gomes, Silva, & Marcelino, 2005, p. 1).

3.1 Project Objectives

The main project objectives were:

- To foster interest in historical and cultural heritage, leading students to reflect, investigate, disseminate and share it.
- To acquire some skills through motivating and meaningful learning in local context.
- To encourage teamwork spirit in multidisciplinary groups.
- To develop a collaborative and research work of curriculum content associated with the use of Web 2.0 tools, including Google Earth and smartphones.
- To share information on the Internet as a way to promote the local environment, in conjunction with the school and the Local Authority.

Achieving these goals was based on methodological principles of active and constructivist pedagogies, namely:

- Discovery and problem solving learning;
- Learning in local context and through direct contact with the sources and the handling of materials;
- Learning through Information and Communications Technology (ICT).

3.2 Method

A pilot group was formed that drafted the historical and documentation research necessary for the development of the georeferenced historical route.

It was outlined a 1st work plan with a schedule of workshops according to the availability of the group. Relevant information was made available via Moodle, in a discipline created for this purpose - Local History and Heritage (HPL). Online work was preferable, especially with respect to the preparation of texts to integrate in the route "placemarks". Alongside the group was getting familiarized with the software and the technology to be used.

The remaining students of the class received the tutorials of the software applications to be used and were aware of the issues under study.

3.3 Technology

The field activity - georeferenced historical route - besides other multimedia tools, was based in the use of technological resources such as smartphones, Google Earth and the Active Track software.

Windows Mobile, of Microsoft Corp™, Apple iPhone™ and Google Android ™ transformed the mobile phone concept, which has become a small personal computer – a Personal Digital Assistant (PDA) and a Smartphone (the latter with an open operating system allows users to, apart from all other functions, integrate personal software). Realizing this asset for Education, the Centro de Competência TIC «Entre Mar E Serra» (CCEMS), in partnership with the Portuguese Ministry of Education, developed a software to create georeferenced active routes to be used on smartphones with the Android system – the Active Track software, which can be downloaded on smartphones and after edit the routes created in GE (CCEMS, 2008).

The Active Track software is easy to use and has clear and complete tutorials. A route is made by points (the number depends on the type of route, but there is no limit). When one creates a point the program allows the inclusion of text (according to the information that is relevant) in four models - text only, text with an image, text interspersed with pictures and text with a form. It also allows the integration of multimedia content (photos and audio - Mp3 or other audio files and YouTube videos) and links to Internet sites.

Point of interest coordinates to visit can be imported from GE (the software has an option for that) or can be inserted into the compass card. A Google KML file (latitude, longitude and the title of each point) can also be imported. The route data will be stored on the computer hard drive later. A route can always be reedited and it is possible to preview the point being edited.

So, for the field activity, after selecting the route on the PDA (for which it has been exported), each group had to trigger the recording (REC appeared on the screen), and from that moment on the groups had to orient themselves in situ. The route appeared on the screen through “balloons”. Clicking in a “balloon” the point name appeared. The distance to the points was given on the left side of the screen, regarding to the point that was being followed; on the right side the distance to the nearest point could be seen. At each point there was audio information, text information and sometimes pictures. When they reached a point coordinates, the phone emitted a beep, and then appeared on the screen the information entered for that point. This information was given in audio, whenever transmitted by the mayor, see below, but the text and the images also appeared on the screen. When it was only text (which happened in four points along the way), this was always complemented by medieval music.

At any route point a photo could be taken. Each taken picture added a point to the route. In all placemarks there were tasks to be done that included this feature and also writing a text that could simply be the photo caption.

After conclusion of the route, and the recording on the smartphone, it was downloaded to the computer for posterior visioning in GE, with or without editing. The edition work is important and complementary, as it also helps the consolidation of knowledge, as it leads to activity analysis and reflection - in each placemark one can include more information (including links) or simply format the information introduced along the way, from the pictures to the text. Also new placemarks can be included. For editing the KMLBuilder software from NorthGates Systems was used. KMZ files can be hosted on any platform, Website, or computer, and to be displayed it is just needed to have GE installed.

Another strategy that can be used is to create content directly in GE - folders can be created that include the placemarks, the paths or the routes. Students can interact with diverse placemarks, enrich their work with their own findings and resources, and create hyperlinks. Using the HyperText Markup Language (HTML), video and audio can also be incorporated.

In fact, GE is a tool available to everybody, given the undoubted advantages that it exhibits:

- It is a virtual 3D globe, with a friendly interface of easy and intuitive navigation;
- It uses satellite imagery, aerial and 3D Geographic Information System (GIS);
- It is free and simple to install (Google provides a plugin or extension module that can be placed on Web pages), adaptable to various operating systems and compatible with the most common browsers;
- It allows the sharing of information and, more important, particularly with regard to its added value in an educational context, it allows the inclusion of data and contents (from text to photos and animations, 3D images, paths, guided tours, placemarks, etc.) – this way the information can grow and be diversified;
- It has great interactivity, allowing virtually travelling by streets, mountains, cities, museums and monuments, explore the Earth and the Space;
- It provides multiple layers of information and services - weather and geological phenomena, unexplored places, such as the deep of the ocean, other planets and galaxies, small places, towns, cities, rivers, mountains, roads and paths, historical places and maps and information about ancient civilizations;
- Its tutorials are accessible and easy to understand.

On the other hand, the technological advances in communications and hardware (mobile phones) allow to combine GE with mobile devices, facilitating its use outside the context of the classroom and contributing to a new educational “paradigm” or a new form of learning - mobile learning or m-learning - that “enable children to reflect on what they are currently engaged in” (Druin, 2009, p.5) and that enhances the collaborative work (in pairs or small groups, or even with the entire class, with or without the teacher).

3.4 The Castle Route

The route was organized around the Arouce Castle - effectively Lousã, a small town of Portugal (in the past called “Arauz”), has a medieval castle (a small watchtower) that, according to the documents, was sent to be rebuild by King Sesnando (the Mozarabic governor of Coimbra, after the reconquest of the city by Fernando I in 1064), along with the castles of Penela, Miranda do Corvo, Soure and Montemor-o-Velho, to strengthen the defense of the city of Coimbra, in what would come to be known as the “Linha de Defesa dos Castelos do Mondego” (Line of Defense of the Mondego River Castles).

Specific questions were intended to be answered:

- Why is the castle here?
- To what context the region “Arauz” belongs?
- What are the earliest documents referring to this toponym?

- What traces and inheritance the Muslims left us?
- How the territory was defended and organized at that time of reconquest?

Also the study of the Pillory, and its inclusion in the route as a georeferenced point, allowed to address the issue of populating the place and simultaneously enabled to understand the essence of the municipal power and the evolution of the local government.

The route has approximately 3.5 km, starting at Lousã Escola Básica N. 2 (Middle School N. 2) and ending at the Castle, with 8 georeferenced points of patrimonial interest and that illustrated the curriculum subject matter under study. The route driving was assured by “Mem Afonso”, the mayor of the Castle in 1154, that students turned into an avatar and to whom they gave voice - the texts for each georeferenced point (resulting from the research done) were recorded in Mp3 files (with a student voiceover) and inserted into the route points (see Figure 1).

Figure 1. Following the Castle route and stopping at a point (Pillory).

Aiming to make the “Castle Route” more dynamic, in some places, Geocaching activities were associated (see Figure 2).

Figure 2. Editing a “placemark” of the Castle route and doing a geocaching activity (at the Castle wall).

After the field trip, the several recorded group routes were downloaded to the computer, edited and visualized in the classroom, along with one edited by the teacher (see Figure 3).

Figure 3. The Castle route, a specific "placemark" and the whole route.

After the whole activity was completed a survey was developed by the teacher and passed to the students. The analysis of the survey results allow us to conclude that the activity was very positive, that students liked to do it and that they learned from it. Students said for instance that:

- The activity "has helped to know better" and "to realize the value and the meaning of heritage."

At the level of historical understanding, responses given showed that there was a better awareness of the notions of space/time and of the role that each one can play in the society in which they live, being this way enhanced the social function of history. It can therefore be concluded that the process has been a dynamic and motivating one where technology leveraged a collaborative and constructive learning and that contributed certainly to the development of the thinking and historical consciousness of the students, who, in a critical and autonomous way, were able to establish the link between the past and the present through the use and creation of dynamic content.

The technological resources used potentiated a collaborative and constructive learning, providing a pathway to a distant past. The technology "connected" students, allowing them to "experience" history and overcome the barrier of abstraction that sometimes hinders knowledge.

The used methodologies, supported by the technological resources motivators and facilitators, allowed to achieve the objectives previously defined:

- Strengthening of historical consciousness and identity;
- Respect for the preservation of cultural heritage;
- The importance of heritage and local history in the students' cognitive process and motivation;
- The need to bridge the gap between the past and the present through the discovery of the thread of the human history, in different times and places;
- Their own knowledge construction using last generation technologies.

4. CONCLUSION

The school has to be "one of the pillars of the information society" and provide motivating and enriching learning environments that accompany the evolution and change, in a process of knowledge sharing. Research and studies say that for today's children, who grew up with television, video, Internet, visual modes of learning are extremely important, so the technologies are changing the way we live and learn (Druin, 2003). Therefore, they have to be seen as allies of the teacher in any area of the curriculum and also in History. Not for its use in itself, but because they enable the development of core competencies in transforming information into knowledge: "We believed that this conceptual gap between the child's everyday experiences and the abstract formalisms that have evolved in science could be closed by using the potential of multimedia software" (Scaife & Rogers, 1999).

It is therefore essential that teachers take advantage of "a strongly positive view of technology" for the youth ((Druin, 2003, p. 3) and use ICT as a factor of change of practices and an ally in the process of teaching and learning: "Preservice teachers must not simply acquire skills that make them proficient at using technology, but also learn how to use technology to make their teaching better than it would be without it" (Mason, et al., 2000, p. 109).

With the HPL Group it has put into practice a model of computer-mediated learning, based on a socio-constructivist pedagogy. Experience with this small group has shown that students learn more and better when they are the authors of the knowledge construction process, that the construction of teaching materials gives great significance to learning and contributes to the development of reasoning and critical thinking, that the work with the sources and the research in a local context is possible, motivating and challenging. The technology "connected" students, allowing them to "experience" History and overcome the barrier of abstraction that sometimes hinders knowledge.

In education, particularly in the teaching of History, ICT and media are an asset that have to be integrated in the practices and instructional strategies, as they are facilitating tools that encourage creativity and autonomy, have a great potential for motivation, promote networking and information sharing, and last but not the least contribute, by young people, for the appropriation of technological literacy and skills that will allow them to integrate the Information and knowledge society.

"A typical feature of classroom instruction following recent technologies and social developments is the use of project - and problem-based learning activities that emphasize collaborative learning in authentic situations, the active construction of knowledge in social interactions with peers and experts, goal-directed information search processes and synthesizing across multiple sources" (Kumpulainen and Wray, 2002). The school has to keep on this path – assuming questioning and a critical and reflective attitude as the base of knowledge building.

Next steps of this study will involve to apply this approach to other topics of the history discipline in subsequent academic years, including to other grades, and to consider its applicability or integration with other disciplines and curriculum areas too.

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INTRIGUE AT THE MUSEUM: FACILITATING ENGAGEMENT AND LEARNING THROUGH A LOCATION-BASED MOBILE GAME

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ABSTRACT

The use of portable devices to explore informal learning environments has recently exposed museums to a mobile learning (m-learning) scenario. In particular, location-based mobile applications that take into account not only a specific physical venue, but also the personal and social context can be valuable resources to enhance the visitor experience. Game-based applications that leverage on fun and social interaction to facilitate the meaning-making process represent a promising approach, since they favor both learning and entertainment activities. This paper presents the design and evaluation of "Intrigue at the museum", a location-based game addressed to children visiting Palazzo Madama-Museo Civico d'Arte Antica (Turin, Italy). This piece of work offers a methodological insight into the evaluation of engagement as a precursor of learning and provides evidence that a resource of this kind can contribute to a meaningful and enjoyable exploration of the museum by children.

KEYWORDS

Mobile educational games, context-awareness, pervasive learning spaces, informal learning environments, museums

1. INTRODUCTION

The speedy development of mobile technologies is now providing free-choice informal learning environments such as museums with new opportunities in terms of communication, education, entertainment and social sharing of the experience. Through the use of context-aware mobile applications supporting the visit, museums can turn into pervasive learning environments, where the bridging of the objects of the real world with a virtual environment by means of mobile tools can contribute to the learning process (Laine et al. 2010). Additionally, the adoption of gamification techniques that integrate game elements in non-gaming systems to improve user engagement (Deterding et al. 2011) may represent an effective way to involve specific target audiences, fostering their attention and interest.

At this stage of research, the main barriers that still limit the potential of mobile learning are not technological but social, and concern the understanding of the contexts in which mobile resources are used (Brown 2010). As suggested by authors, in a mobile learning scenario mobility does not only refer to the technology but also to the learner (Vavoula and Sharples 2009): the learner not only interacts with the devices in specifically situated physical and social contexts, but these interactions generate new contexts that may ultimately affect the learning process. As a consequence, the evaluation of mobile experiences taking place in real settings can help better understand to what extent the use of mobile resources can affect the contexts in which learning takes place.

Among the questions that emerge in this field of research, an issue that partially remains unsolved is the obtrusiveness of the technology: accessing mobile educational resources during a museum visit can be distracting and ultimately induce visitors to focus more on the device itself rather than make them taking the most of their situational experience (Simarro Cabrera et al. 2005).

In this framework, how can context-aware systems support museum visits in a non-intrusive way? How can they help visitors meaningfully explore the museum environment without distracting them from the real exhibits and the social context of the visit? (Lonsdale et al. 2004)

If we accept a definition of learning as a socially mediated meaning making process (Vygotsky 1978), it is evident that the provision of experiences that do not isolate visitors but leverage instead on the social component is particularly important, both to enhance the learning potential of mobile tools and meet visitors' edutainment agendas. Beyond knowledge, a desired outcome of the experiences is fostering a positive attitude towards the exploration of the institution and museums in general.

Additionally, given that it is now commonly agreed that learning is facilitated by a state of flow and engagement experienced by the learner (Csikszentmihalyi and Hemanson 1995), the attempt of effectively providing educational leisure experiences that leverage on visitors' attitudes towards learning for fun has become relatively common (Packer 2006) and the role that mobile technologies may play in this process is worth-investigating, especially if we consider the opportunities offered by pervasive gaming.

Coherently with this framework, this paper describes and critically analyzes "Intrigue at the museum", a game-based mobile application designed for children aged 7-13 visiting Palazzo Madama-Museo Civico d'Arte Antica, an ancient art museum located in Turin (Italy). The paper is organized as follows: section 2 revises the relevant previous works; section 3 presents the structure of the system and the solutions that were developed; section 4 discusses to what extent a location-based application of this kind can represent an obstacle or an opportunity for the fostering of learning in a museum venue. Finally, section 5 identifies lessons learnt and future areas of research.

2. GAME-BASED PERVASIVE LEARNING SPACES IN MUSEUMS

The use of context-aware mobile games matching educational and entertainment goals has been experimented in a variety of museum contexts in recent years: with regard to context-aware applications including augmented reality features, the research questions that have been usually investigated mainly concern the efficacy of these applications in terms of (i) communicating cultural content, (ii) fostering a purposeful interaction with the objects on display and (iii) encouraging the social sharing of the experience (Thian 2012; Mannion 2012; Botturi et al. 2009). If the use of dedicated mobile applications to explore museums may definitely attract visitors' attention and represent an element of curiosity in itself, a concern raised by practitioners and scholars is that this use could also actually distract users from the real objects, the physical environment and social exchange (Scanlon et al 2005; Lonsdale et al 2004), ultimately limiting the learning potential of the experience. Additional elements of discussion are the provision of challenges that balance the skills of users (Simarro Cabrera et al. 2005) and the invention of tasks and stories that are able not only to hook but also to maintain visitors' attention: these issues are particularly relevant since they may influence visitors' level of engagement and their meaning-making process.

Case-studies show that pervasive mobile games used as learning tools in cultural venues are generally enjoyed by young participants (Thian 2012; Mannion 2012; Botturi et al. 2009; Waycott et al. 2005); however, it must be noted that even though general statements about the ability of the game to engage visitors are mentioned by authors, quantitative data are not always provided, making benchmarking difficult. If the acquisition of knowledge is usually regarded as one of the most important outcomes of mobile gaming in museums, the use of mobile tools in the museum context can be beneficial for other reasons, too. For instance, children aged 6-9 interacting with a mobile game at the British Museum manifested as unintended learning outcomes stemming from the mobile activity the improvement of kinesthetic skills: children improved their coordination with regard to the scanning of tags while progressing in the game and repeating the gestures needed to activate the tags (Mannion 2012). Another important outcome that has been underlined as particularly important by authors is the facilitation of social interaction. With regard to this aspect, the analysis conducted at the Asian Civilizations Museum pointed out that a mobile game developed to convey cultural content on Chinese terracotta warriors was effective in fostering a purposeful social interaction between parents and children (Thian 2012); other examples have also stressed the potential of mobile tools in fostering peer-to-peer interaction (Waycott et al. 2005), whereas the shared use of a 7 inch tablet among a group of teenagers was found inappropriate, instead (Mannion 2012), confirming that external conditions and the social composition of groups may influence the effectiveness of the m-learning experience.

The types of activities and approaches proposed through the applications may influence the experience, too: narrative approaches aim at emotionally engaging visitors with the story that is being told (Lombardo and Damiano 2012), whereas more constructivist and task-based experiences usually encourage self-directed exploratory behaviors. Given that both the approaches are appreciated, the selection of the method to be followed should be tailored by developers according to the goals and the learning theories at the base of the mobile experience.

3. INTRIGUE AT THE MUSEUM: A LOCATION-BASED MOBILE GAME FOR CHILDREN

Coherently with a mobile-learning scenario, a location-based mobile game was developed in 2012 for Palazzo Madama-Museo Civico d'Arte Antica, a UNESCO-listed historic residence located in Turin (Italy). Particularly renowned for its baroque style, the building presents architectural evidence of the history of the town from the Roman times to the present ages and it now hosts a museum with an extensive decorative art collection: due to its complex identity, it was thus decided to develop a mobile application that could help young visitors aged 7-13 to cognitively orientate themselves in the building and encourage a positive and purposeful exploratory behavior. Due to the lack of Wi-Fi connection in the museum, it was decided to implement a vision-based system: users could access multimedia content by scanning the tags deployed in the museum environment, using the camera of a 7 inch tablet borrowed at the museum entrance.

3.1 Goal of the Game

"Intrigue at the museum" was conceived as a mobile application aiming at facilitating engagement in young museum visitors, an audience that can easily get annoyed or even worse, frustrated, in such a context. Particularly, the application aimed at providing a solution to the lack of focused interest and to the absence of preliminary information frequently lamented in the literature (Lonsdale et al. 2004).

The goal of the game was to provide children with a pleasant and rewarding experience, combining the exploration of the halls with the provision of activities that could not only foster the acquisition of knowledge about the exhibits but also generate a positive attitude towards the exploration of the venue and museums in general (Hooper-Greenhill 2007).

Apart from being an indicator of a pleasurable experience, engagement was considered as a desirable outcome since scholars of different disciplines agree that it is a catalyst for learning (Bitgood 2010), together with positive affection and the development of a state of flow (Csikszentmihalyi and Hermanson 1995) where the learner feels absorbed by the activity and manifests the will to keep up with it. More specially, "Intrigue at the museum" aimed at fostering affective engagement, which occurs when an experience is enjoyable. Considering that teenagers and children may visit museums neither with a deep background nor with a specific interest in the museum subject, the game was intended by developers as an element contributing to foster curiosity and situational interest, a state which is elicited precisely by certain aspects of a situation (Arnone 2011, Packer 2006).

3.2 Description of the Game Mechanics

"Intrigue at the museum" is a single player game and its plot is to find a thief in the museum among a set of virtual characters. Clues are given to the player as she solves riddles after scanning tags deployed in the building. Coherently with a constructivist approach, it was decided not to suggest a defined path to follow, but to allow children freely explore the museum environment, according to their interests and family's agenda.

Overall, the application was structured around two key-points: exploration and tasks. Location aware applications aim to contextualize learning activities by interaction with the surrounding environment (Patten et al 2006). Location is used to provide contents based on the position of the learner. The main benefit of this kind of applications is that they make the user explore the pervasive learning space, in our case a museum.

Besides exploration and contextual information, "Intrigue at the museum" pursues also the goal of making a visit at the museum enjoyable for the young visitors while preserving the educational contents of such an experience. Motivation is a strong lever and very important in learning activities that can take profit of gamification principles and Task Based Learning, a learning method that relies upon practical activities to construct knowledge and develop skills (Bellotti et al 2011, Willis 1996).

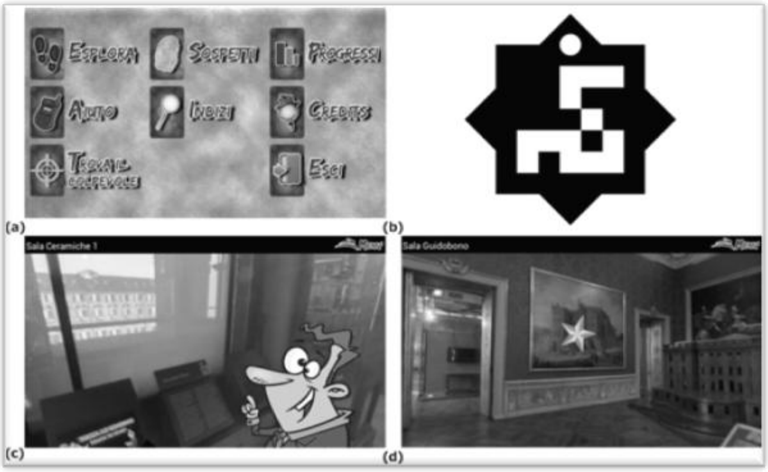

Figure 1. Game’s main menu (a), marker for the location aware system (b), example of a guard of the museum (c) by touching the star, the player gets access to the mini-game (d)

The first screens of the application show the mechanics and the rules of the game. The main menu (Fig 1.a) gives access to the game statistics, the progress, the clues already collected and the list of the suspects (Fig 2.a). This first version is only in Italian but in the future there will be also an English one. Selecting the ”Explore” function (Fig. 1.a) and scanning a tag (Fig. 1.b) with the camera of the devices, a 360° view of the current room, augmented with a virtual “museum guardian” and some space clues, is presented to the player. Interacting with the character, (Fig. 1.c), the player receives information on the history of the palace or on works on display in the room. Then, the player has to solve a mini-game that is related to the knowledge she/he has gained or that involves interaction with a work of art on display in that particular zone (Fig. 1.d).

Figure 2. Intrigue at the museum: the list of suspects (a), examples of observation (Puzzle) (b), reasoning (Quiz) (c) and arcade (Clean the Dirt) (d) mini-games

These mini-games are all related to the museum master-pieces as their goal is to make the user look at them under a special perspective that makes it both interesting and fun. By solving these riddles the player earns a “clue card” containing a piece of advice on who is or who is not the thief.

The mini-games were developed following the paradigm of Task Based Learning, and can be classified into three main categories:

- Observation tasks, pushing players to carefully observe the masterpieces looking for the details needed to solve the game (Fig 2.b)
- Reasoning tasks, where initial clues, such as temporal information, factual details and so on, have to be absorbed by players in order to solve the riddles or quizzes (Fig 2.c)
- Arcade tasks, used to provide observation stimuli entertaining the players with animated graphics and quick interaction (Fig 2.d)

By finding the thief the player earns a “detective certificate”. In order to achieve this result almost all the building has to be explored for collecting the clue cards.

4. EVALUATION OF THE EXPERIENCE: RESULTS AND DISCUSSION

Coherently with the theoretical framework presented in the previous sections, evaluation aimed at identifying the degree of obtrusiveness of the technology and the level of engagement, social interaction and focused exploration facilitated by the application. Additionally, the most appreciated game mechanics were investigated too, in order to guide future developments of similar games.

Research questions were addressed following a mixed-methods approach combining quantitative and qualitative research. Following the example of other authors (Brugnoli et al. 2007), the conduction of unobtrusive observations was deemed as the most appropriate method to investigate young visitors’ behaviors and identify patterns of interaction with the device, the museum environment and group members. Adults accompanying children and teens having used the application were asked to answer to a questionnaire after the visit, in order to collect a set of perceptions about the level and kind of engagement manifested by young visitors when playing with the game. Moreover, questionnaires served as a trigger to start conversations about the game with adults and young visitors. The factual acquisition of new knowledge was not measured, due to the difficulty of identifying visitors’ previous knowledge and involve them in pre and post activities to register the degree of learning occurred (Falk and Dierking 2000). However, evidence of learning was qualitatively recorded paying attention to visitors’ conversations (Naismith et al 2005).

4.1 Unobtrusive Observations

During the evaluation, 30 young visitors playing with the game were unobtrusively observed. Individuals were randomly selected in the museum venue among children and teenagers clearly holding a museum tablet. In order to understand and code players’ behavior, key-indicators of engagement were identified among contributions focusing both on educational computer games and museum learning (Bitgood 2010). Starting from visible characteristics of engagement, a list of verbal and nonverbal indicators was elaborated.

Results pointed out that 83% of young players revealed one or more signals of engagement, with the most frequent being hunting tags in the museum, walking fast, pointing at tags while saying aloud sentences such as: *”Look! There’s another one (i.e. tag) over there!”*; *”Let’s go and find another one!”*. A positive and purposeful interaction with the works of art on display, detected through the monitoring of behaviors, gestures and conversations, was registered for 56% of the players observed. In the 20% of the individuals a non-desirable behavior was recorded instead: children were so concentrated on the game that barely paid attention to the museum environment, suggesting that technology was highly intrusive for this sample of users. The rest 24% did not show externally detectable signals of purposeful interaction with the works of art on display instead, even though a meaningful interaction cannot be excluded. The analysis of verbal and nonverbal indicators also pointed out that interaction among young players and adult companions or peers was registered at least for 73% of the sample observed. Interaction was identified both through the detection of collaborative behaviors (i.e. adults or peers helping children to solve specific tasks; adult companions gazing at the tablet to follow their children’s activities; physical proximity between children and other members of the group) and conversations such as: *“You have to match these items”*; *”We need to find this. Let’s get closer, so that we can look better at the painting”*. The social sharing of the experience was particularly intense among peers: in fact, collaboration was identified in 10 of the 12 groups including more than one child/teenager; apart from behavioral patterns of collaboration similar to the ones described above, sentences such as the following represent evidence of purposeful collaboration: *”Come here, I will show you how to do it”*; *”Now it’s your turn”*; *”I think that we’d better do this”; ”Why don’t we do this?”*. The data have thus pointed out that the mobile game was effective in fostering conversations and collaboration both between adults and children and couple or small groups of young participants. Even though it is not possible to state to what extent the engagement excited by the gaming experience was effective in fostering learning, evaluators took notes about players' conversations, providing evidence of the learning potential of the mobile game. For instance, a boy reported to his mother that *"All the female figures painted on the ceiling have the same expression and represent the Royal Lady"*, which is a piece of information that could be gained only through the playing experience.

4.2 Questionnaires

During the experiment, 81 questionnaires filled in by adults visiting the museum with the children who played the game were collected. Data referring to the sex of young players report similar percentages for boys (46%) and girls (54%). The age of participants spanned between 6 and 16 years, registering a peak for children aged 10 (Fig. 3.a).

In order to have an insight of the emotional engagement manifested by young players, adult companions were asked to define the feelings of children when playing with the game; a list of adjectives was provided, but adults had the chance to write any other adjective they felt appropriate. Results show that selected adjectives had almost exclusively a positive connotation (Fig. 3.b), indicating the effectiveness of the game in fostering a positive emotional engagement towards the experience. The fact that the gaming experience was mainly perceived as positive and effortless may indicate that "Intrigue at the museum" was effective in balancing challenges and participants' skills (Csikszentmihalyi and Hemanson 1995), suggesting that the design of the game was appropriate for the target audience. Opinions verbally expressed by children and adults when commenting on their answers underline the importance of carefully design reliable game mechanics that meet visitors' expectations: in fact, disappointment was mainly due to the presence of non-active tags and to the inability of successfully scanning tags placed in dark spots, resulting in a lack of access to new challenges. These results seem to indicate that once exposed to a mobile learning scenario, players adapt to the system (Scanlon et al 2005) and expect to explore and learn.

According to adults' opinions, the aspects of the game young visitors mostly appreciated were the solving of challenges and the tag-hunting (Fig. 3.c). A smaller percentage of participants mentioned the general aim of the game (i.e. finding the thief) as particularly valued, whereas just a minority stated that children and teens did appreciate information concerning the history of the palace and the museum collections. These results indicate that the game mechanics were effective in facilitating an enjoyable exploration of the museum as a physical context and that the design of puzzles, quiz and riddles that leveraged on players' sense of self-pursuit was an element of success, too. These results also identify areas of future improvement in the story-line and in the way cultural content is conveyed: it should be more deeply integrated in the game mechanics, in order to maximize the learning experience young visitors are unconsciously exposed to through m-learning tools (Schaller 2011).

Data collected with the questionnaires confirmed that children and teens mainly played with adult companions (46%) and - if present- peers (31%). An in-depth analysis of social interaction patterns pointed out that young visitors mostly shared with adult companions their feelings, the description of the challenges and the cultural content provided. Children and teens asked for adults' help especially for answering to quizzes (85%); other riddles were solved with a lower degree of external help (62%), instead. This suggests that quizzes concerning cultural content were felt as more challenging and it forces a reflection about how effectively communicating cultural content during the gaming experience. Since the game was developed to foster a meaningful and deep exploration of the museum context by players, the amount of time spent by participants was also registered.

On the average, people spent 107 minutes playing, being 41 minutes the minimum and 236 minutes the maximum. Considering that previous studies pointed out that the average permanence inside the museum manifested by visitors was 80 minutes, it can also be postulated that the game actively contributed in stimulating a longer permanence inside the museum.

In order to test this hypothesis, further studies including control groups and focusing on the amount of time specifically spent by families inside the museum will be needed. However, comments provided by adult companions while answering to the questionnaires further support this hypothesis: *"We've never been in a museum for so long!"* (mother of a 9 years old girl); *"We came to the museum to visit the panoramic tower,* *but then we've started to use the mobile game and we've explored the whole museum"* (father of a 10 years old girl). Other studies have reported a similar phenomenon (Sharples et al 2007) and have stressed the correlation between the time spent at the museum and the degree of learning occurring (Sandifer 1997).

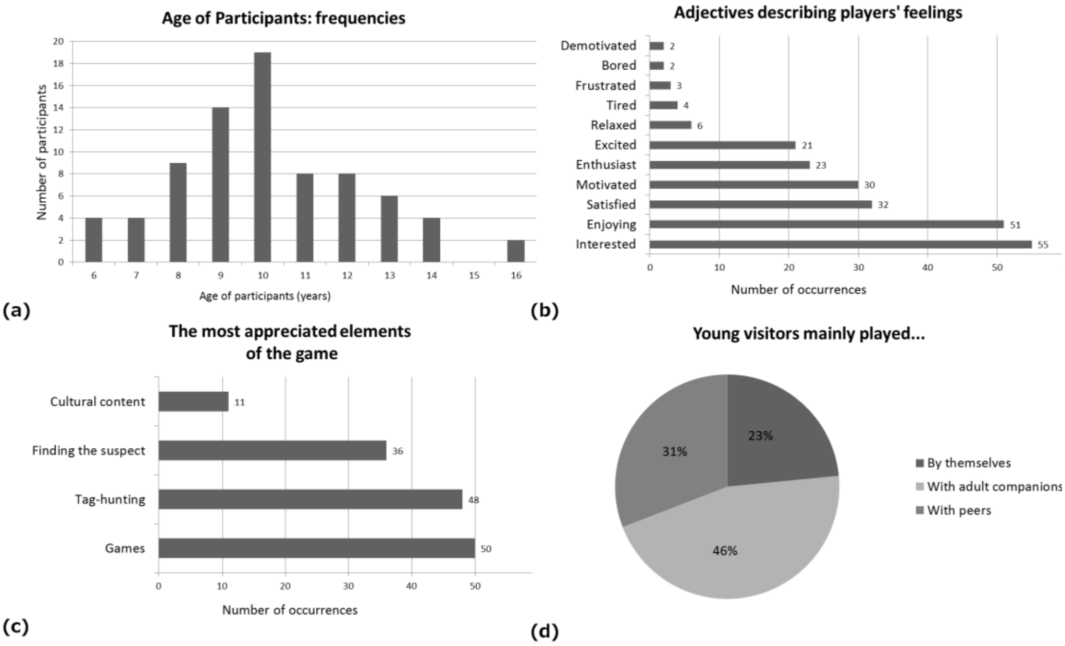

Figure 3. Questionnaires results: age of participants (a), players feelings about the game (b), game appreciation (c), social interaction (d)

While not explicitly measured by the questionnaires, the observations carried out during the evaluation show that only a fraction of the young visitors remained stuck to the device screen, while most of them clearly showed a positive attitude to the surrounding environment, manifesting curiosity and interest towards the exhibits: *"Look! How strange is this object!"*, *"These medallions look very similar, but they are all different!"*.

5. CONCLUSION

This paper has shown that location-based mobile games may represent a valuable m-learning resource in the museum scenario, since a careful design of the proposed activities can limit the obtrusiveness of the technology and facilitate engagement, a precursor of learning. Given these results, a future step of research will be measuring the acquisition of factual knowledge, asking children to participate to pre and post visit tests. Nevertheless, the positive feelings manifested by participants during the gaming experience and the significant amount of time spent at the museum when playing suggest that the use of the application was successful to achieve a desired learning outcome: making children want to explore the museum environment and fostering a positive attitude towards the exploration itself. In order to take into deeper consideration the mobility of the learner, future areas of development could be represented by providing connectivity to the devices, so that some elements of the gaming experience could be shared through social media platforms and translated to the everyday life of the learners. Finally, adding the game a higher degree of control from the user could represent another possible work direction, making the application even more reacting to visitors' choices and resulting in a more personalized experience.

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MOBILE-BASED CHATTING FOR MEANING NEGOTIATION IN FOREIGN LANGUAGE LEARNING

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ABSTRACT

This paper analyzes the adequacy of mobile chatting via Whatsapp for the enhancement of a type of spontaneous and colloquial written interaction which has a strong connection with oral discourse. This is part of a research project undertaken with Spanish students of German as a foreign language with a beginner's or quasi-beginner's level. The paper presents the context and parameters of this learning experience and the methodology followed. Then, an analysis of the results is undertaken in terms of student response, attitude and participation, and also in terms of the meaning negotiation strategies and language used. Finally, conclusions are drawn regarding the adequacy of the Whatsapp technology for the practice and improvement of interactive skills for foreign language students at the initial learning levels.

KEYWORDS

Mobile-based chatting, Foreign language learning, the discourse of spontaneous interaction

1. INTRODUCTION

The use of mobile devices, especially mobile phones, has risen considerably in the new millennium, with near 6 billion mobile cellular subscriptions according to figures published by the International Telecommunication Union[1]. With a society "on the move", constantly connected thanks to the increasingly technological sophistication of mobile devices and the speed of wireless networks, it was a matter of time until all these tablet PCs, smartphones, etc. started to be used in education.

The concept of mobile learning has several implications (Kukulska-Hulme & Traxler, 2005): it can refer to learner mobility, since educational activities are no longer fixed to a physical location, but it also signifies the fact that all these small, portable devices are naturally mobile. However, the fundamental novelty of this way of learning is that it has led to a re-definition of the learning experience, which now can take place anywhere, anytime and for last as much or as little as the learner wishes. Actually, it has opened the door to new modalities of education, blurring the traditional distinction between formal and informal education[2].

2. MOBILE-BASED ALTERNATIVES IN THE FOREIGN LANGUAGE CLASSROOM

In the field of foreign languages there has been an increasing interest in the development of MALL (Mobile Assisted Language Learning), with special issues dedicated to the topic in some of the most relevant journals: *ReCALL* (Shield & Kukulska-Hulme, 2008) or *Language Learning and Technology* (Sotillo & Stockwell, 2013) and hundreds of applications that cover a wide range of language learning materials: dictionaries, phrasebooks, educational games or even full language courses.

[1] http://www.itu.int/ITU-D/ict/facts/2011/index.html
[2] This research is part of the SO-CALL-ME project, which is currently being undertaken with funding from the Spanish Ministry of Science and Innovation (FFI2011-29829).

Apart from these resources which are specifically designed for foreign languages, many practitioners and researchers are exploring the potential of these software applications for language learning. A good example is the linguistic application of tools related to social interaction and collaboration, such as Twitter, Facebook, etc. (see for instance Harrison & Thomas, 2007). It is in this context that the research project of this article should be placed: the main purpose of the investigation was to trial WhatsApp Messenger (http://www.whatsapp.com/), an instant messaging application for smartphones that allows mobile-based chatting, and to explore the potential of this software for language learning, together with its affordances in collaborative work and meaning negotiation.

This educational initiative is part of the Research Networks for Teaching Innovation), put forward by the Spanish University for Distance Education (UNED) with the aim of encouraging innovative practices in tertiary education in Spain. This program is part of the European Higher Education Area (EHEA) framework and covers the following fields: curriculum design based on competences, implementation of active learning methodologies, models for formative evaluation and new forms of tutoring adapted to the EHEA. The project presented here belongs to the second type, implementation of active learning methodologies, which is something crucial in our institution, given the profile of our students. The UNED is the main university in Spain to provide distance education to adults and has over 260,000 students, with an average age of over 35 (www.uned.es). Since its beginnings it has strived to apply the latest technological developments to learning, with its own virtual campus, called aLF, and Web-conferencing system (AVIP). As for language learning applications, the ATLAS (Applying Technology to LAnguageS: http://atlas.uned.es) research group has been working in the multidisciplinary field of learning technologies and Computer-Assisted Language Learning (CALL) for over fifteen years now, being the three authors of this article part of that group.

It is, therefore, natural to try and find learning formulas that adapt to the changing profile and needs of our students, who are “distance learners on the move”: familiar with e-learning methodology and also users of smartphones and social-networking apps such as WhatsApp (Riyanto, 2013). There has been a lot of criticism against the use of communication technology, especially in text messaging, because of the usual careless and faulty language used (characterized by an extreme simplification of spelling, a reduction of morphemes and somewhat telegraphic syntax; Mphahlele and Mshmite, 2005). The interest of this paper lies in the use of this software for collaborative language learning, drawing on tools that they already use and re-directing them for an educational purpose.

3. RESEARCH METHODOLOGY

According to Cohen et al. (2011), the qualitative-quantitative distinction in the research of applied linguistics is an oversimplification because it is necessary to consider the following three variables: the data collection method (experimentally or not), the type of data yielded (qualitative or quantitative) and the type of analysis conducted (statistical or interpretive). These three variables should provide with two ‘pure’ research paradigms: the ‘exploratory–interpretive’ (non-experimental, qualitative data, interpretive analysis) and the ‘analytical-nomological´ (experimental, quantitaive data, statistical analysis). In addition, Nunan presents six hybrid forms (1992). The present study follows one of these mixed paradigms: the ‘experimental-quantitative-interpretive’, according to which authors examined first some quantitative data in order to reveal participation patterns, obtaining statistics through experimental study and survey analysis. The use of qualitative data gathering techniques such as questionnaires enabled the collection of background information about students’ experience with technology-enhanced language learning.

A qualitative approach was adopted to investigate the negotiation of meaning (modification of input and interaction) carried out by the students during the WhatsApp activity, analyzing the written interaction in the chat sessions. With that aim, the functions and content of contributions were analysed in the written conversations generated via WhatsApp, to clarify how students negotiate in order to make sense and create meaning in this language interaction.

3.1 Participants and Procedures

Over a period of six weeks, 85 volunteers, initial learners of German as a Foreign Language (*Deutsch als Fremdsprache*, DaF) took part in a structured exploration of the potential of WhatsApp as a medium for collaborative learning of German. They were all Bachelor students enrolled in an initial-level German course for native Spanish speakers at the Spanish National University for Distance Learning National University of Distance Education (UNED). The authors selected WhatsApp to analyse the usefulness of mobile-based chatting for meaning negotiation in initial-level German writing because it enables users to exchange messages without having to pay for them. WhatsApp was also deemed as the most appropriately toolbecause it was handling ten billion messages per day as of August 2012 and it has been growing in the last 2/3 years at a record pace, so the fact was that many of the students were still using WhatsApp for private conversations. Another reason to opt for WhatsApp was that it works on all major smartphone models regardless of their operating systems – iPhone, Android phones, BlackBerry, Nokia and Windows Phone.

In order to increase students' interest in the WhatsApp task, the participation in the activity contributed to the final grade. The score only depended on the amount of messages and did not measure their linguistic correctness. Out of 450 students who were invited to participate in the free WhatsApp task, 85 students (58 female und 27 males) expressed interest. They were divided into five groups attending to following selection criteria:

- Students' topics of interest expressed in the pre-questionnaire,
- homogeneity in terms of the number of participants,
- heterogeneity in terms of language level, so each group was created with *real beginners* and also with students with a higher level of German (Common European Framework of Reference for Languages A2/B1), so that they could help *real* beginners in meaning negotiation.

Those students who did not wish to participate were given alternative assignments to complete, and their data were not included in these study. Students were evaluated in that subject by a continuous assessment method that includes a final exam. Within the continuous assessment, the activity to improve written competence consists in the production of an essay about specific given topics, relating to the semantic field covered within the syllabus of the course. With the aim of facilitating that task, the authors proposed students to participate in the voluntary task on WhatsApp, so they could undertake a collaborative writing activity. Therefore, they had to complete an initial and final survey and to post a minimum of three WhatsApp messages a week. In order to give students a maximum of flexibility and opportunities for written interaction the role of the teacher began including greetings and then making a theme proposal for the written interventions. Then students began immediately to use the instant messaging platform and only sometimes the teacher proposed text corrections and new themes.

4. DATA ANALYSIS

4.1 Usage Patterns

For the purposes of this paper, the data offered has focused on one of the five groups, as an illustration of common usage patterns in written interaction via mobile devices. The duration of the project was six weeks half way through the first semester, as previously stated. It was planned this way in order to give students time to get familiar with the course and the group dynamics. It should be noted here that it took students a little while to warm up to this initiative, since it got a somehow cool response in the first week of the project, with a total of 60 interventions as shown in figure 1 below. However, this trend seems to have changed dramatically in the following two weeks, when the number of students' interventions almost trebled, reaching 166 in the second and third weeks. The remaining three weeks somehow stabilized this "instant-messaging frenzy", with 113 interventions in the fourth week, 127 in the fifth and 123 in the last week of the project.

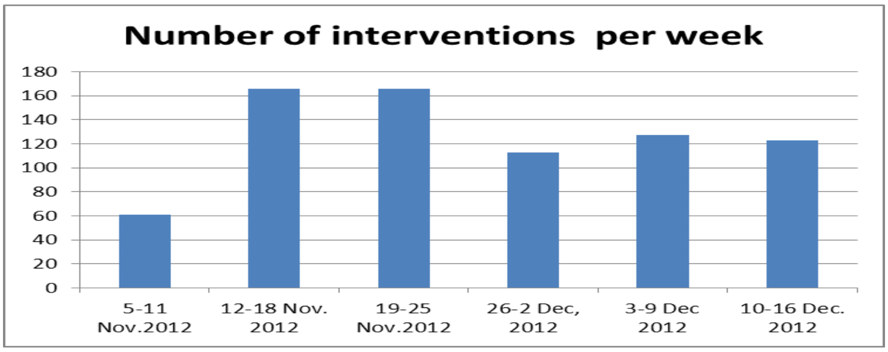

Figure 1. Number of interventions per week

Looking at the daily breakdown and putting the data together by day of the week, it becomes evident that this task was seen by student as a class-related one, to be done during weekdays and not at the weekends. As shown in figures 2 and 3, there is hardly any interaction on Saturday (only 2 messages) or Sunday (18 messages), whereas the preferred days seem to be Tuesday (with a total of 218 messages), Wednesday (161 messages) or Thursday (157 messages).

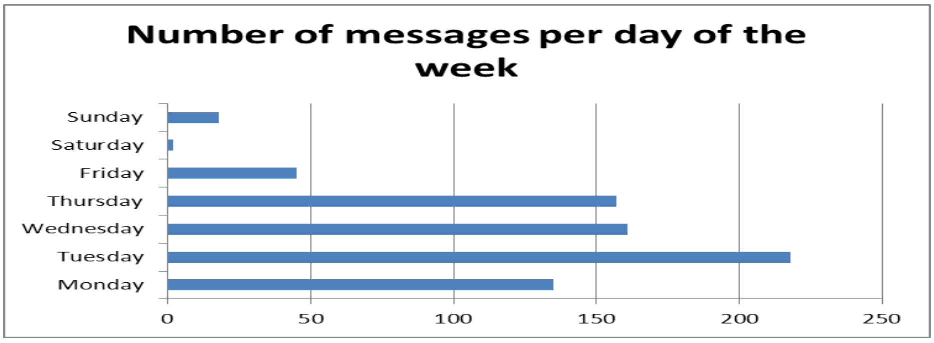

Figure 2. Number of messages per day of the week

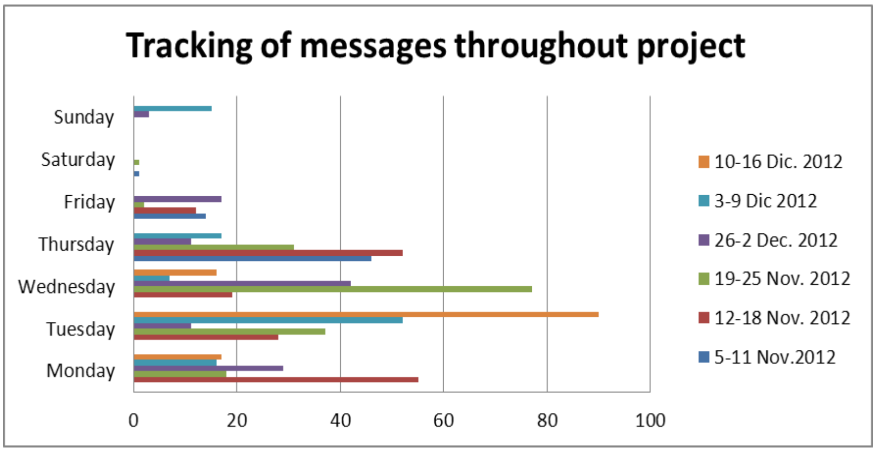

Figure 3. Tracking of messages throughout project

With regard to the time frame, four main distinctions were made: morning (8.00 to 13.00), afternoon (13.00 to 17.00), evening (17.00 to 22.00) and night time (22.00 to 8.00). Again, the data collected (see figure 4) show that students used this instant-messaging software for language learning mainly during what are commonly viewed as "working hours", which would correspond to first two time slots: morning and afternoon together amount to 419 messages (56,93% of the total), in contrast with the time slots that would be considered to be devoted to rest and leisure, evening and night time, which obtain a total of 317 messages (43,08%).

As for the different subjects that took part in this project, for the purposes of this paper, one of the average groups was selected to provide representative data. Students posted an average of 56 messages throughout the whole project. As can be seen in figure 5 below, that is roughly the number of messages posted by the teacher, who tried to act as facilitator, keeping the conversation fluid but letting the students take the initiative. Student 7 and student 8 follow the teacher's trend, with a total of 47 and 51 respectively, but the interventions of student 2, 3, 4, 5, 9, 11 and 12 are well below average. It can be said that half of the students showed a low response rate, but there were three participants who took to instant messaging in German with eagerness: student 10 posted 100 messages, student 1 posted 125 messages and student 6 posted a staggering total of 239 messages.

With the aim of understanding usage patterns in the participants, the authors have undertaken a detailed analysis student by student. Again, the pattern is clear: week days were the chosen ones to participate in this activity. There were only three students who sent messages during the weekend: student 1, student 7 and student 12, and even those sent a remarkably low amount of messages those final days of the week, compared to the rest of the week days (see table 1 below).

Table 1. Number of messages by student and week day

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Teacher	5	17	6	14	4	0	**6**	52
Student 1	16	27	30	35	10	**2**	**5**	125
Student 2	12	2	9	13	0	0	0	36
Student 3	0	2	0	2	1	0	0	5
Student 4	4	2	10	4	0	0	0	20
Student 5	0	0	0	1	0	0	0	1
Student 6	46	77	60	39	17	0	0	239
Student 7	2	26	3	10	1	0	**5**	47
Student 8	11	22	3	14	1	0	0	51
Student 9	2	6	2	8	0	0	1	19
Student 10	33	29	20	9	9	0	0	100
Student 11	0	0	1	1	0	0	0	2
Student 12	4	8	17	7	2	0	**1**	39

When looking at the time slots individually, however, there does not seem to be a consistent pattern, in contrast with the analysis of the group as a whole: student 1 seems to favour the morning slot but also send messages at other times, student 2 concentrates his/her messages within "working hours" (08-13.00 and 13.00-17.00), student 6 sends messages enthusiastically day and night, student 7 is not that enthusiastic, but also sends messages more or less regularly, student 8 avoids the slot 13.00-17.00, student 10 shows a slight preference for the morning and student 12 a slight preference for the evening. The participation of student 3, 4, 5, 9 and 11 is too low to enable the inference of a pattern.

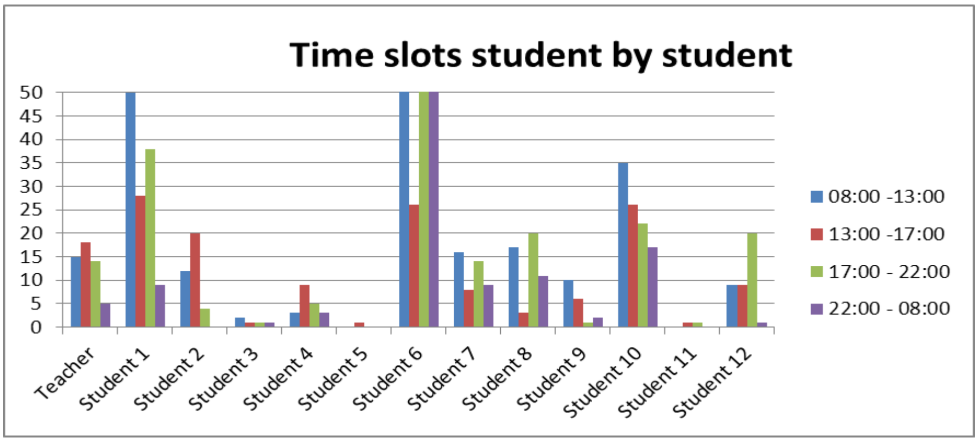

Figure 4. Time slots student by student

4.2 Discourse Functions and Meaning Negotiation in the Whatsapp Conversations

To achieve the aims relating the qualitative approach, the authors investigated discourse functions and content of contributions in the written conversations generated via WhatsApp to analyse how students negotiate to make meaning.

With negotiation for meaning, we mean "a process in which a listener requests message clarification and confirmation and a speaker follows up these requests, often through repeating, elaboration, or simplifying the original message" (Pica, 1994, p.497) On the other hand, according to Hampel (2013) these discourse functions are central in language learning *"…where negotiation of meaning, that is, the modification of input (by using, for example, simple grammar and vocabulary) and of interaction (by, for example, requesting clarification), has been shown to contribute to second language acquisition)".* According to the Interaction Hypothesis (Gass & Mackey, 2007) the corrective feedback resulting from negotiation of meaning is very important for Second Language Acquisition (hencefoth SLA). Researchers state that negotiation of meaning is triggered by a breakdown in communication that leads to a modified utterance (Bower & Kawaguchi, 2011), so, in order to be understood, the output has to be modified.

Analysing the main discourse functions of the text chats, the most relevant that the authors could identify according to Hampels and Sotillos' classification across the five groups were the following: social interaction (greetings and farewells), on-task negotiating meaning, and off-task conversations. The qualitative research has explored these areas by investigating how learners negotiate meanings providing partners with corrective feedback for their language production. According to Bower & Kawaguchi (2011) implicit corrective feedback can take the form of recasts and negotiation strategies. Oliver (1995) identifies four types of implicit corrective feedback that can be grouped together under the category of negotiation strategies: clarification requests (learner are encouraged to modify their output), repetition (the interlocutor repeats a learner's error),, confirmation (the interlocutor checks to confirm its understanding of a learner's output), and comprehension checks (to check the interlocutors understanding).

The next section analyzes the interactions that helped participants to negotiate meaning according to the above mentioned feedback classification within the three main discourse functions identified.

4.2.1 Negotiation Strategies in Social Interaction

Let us first examine some examples of interactions that helped participants to negotiate meaning in social conversations. Extract 1 shows Jaime using the text chat encouraging his interlocutors to rephrase their outputs while they are talking about where they live.[3] According to Gass & Varonis model (1985), the negotiation of meaning begins when the hearer (in our example Jaime), encounters an incomprehensible utterance, a communication problem occurs and he indicates it with a clarification request (*Ich verstehe dich nicht*), what is a form of implicit feedback or negotiation strategy.

Extract 1: Social interaction - type 1 (clarification request)

Elena M.: Ja. Zurzeit ist el Pardo zu geschlossen...
Yes, nowadays El Pardo is closed…

Jaime C.: **Ich verstehe Dich nicht.**
I can´t understand you.

Elena M.: Ich *warte in el Pardo. *Eine groß Teile war geschlossen...
*I *wait in El Pardo. A big part of it was closed …*

Extract 2 illustrates an example of another type of implicit feedback where a student (Carolina) indicates the correct use of a preposition by repeating the sentence using the correct one. As we can see in that example, that type of feedback generates interactions that not only contibute to clarify meanings and so to co-construct knowledge, but also traspasses on the socio-affective level: supporting one another and building relationships in the group. As this extract shows, the teacher (here: *UNED-Alemán*) also used the chat to give written feedback.

[3] The German extracts have been translated purposely literally, trying to maintain student's errors. Errors in both languages were marked with an asterisk *

Extract 2: Social interaction - type 2 (repetition)

Elena M.:	**Ich bin in der Arbeit...**
	I´m *in work
Octavio S.:	Ich bin auch heute *ins Büro
	*Today I´m also *in the office.*
Carolina F.:	**Elena: ich bin bei der Arbeit**
	Elena: I´m at work.
Elena M.:	**Danke, Carolina. Ich bin bei der Arbeit.**
	Thanks, Carolina. I´m at work.
Carolina F.:	Ich korrigiere nur um zu helfen ☺ aber ich mache selber Fehler
	I correct only to help you, but I also make mistakes.

4.2.2 On-task Negotiating Meaning

The following extracts illustrate examples of negotiating meanings related to the task. As shown in extract 3, the topic of the chat conversation was Christmas meals. The excerpt shows Patricia checking whether her interlocutors have understood her, through a direct question. The smartphone self-checker transforms the German word *Strudel* into the Spanish *trueno* (thunder), which produces a communication breakdown, both interlocutors Pilar and Cristina encounter an incomprehensible utterance:

Extract 3: On-task negotiating meaning - type 3 (confirmation)

Silvia R.:	Verstehe nicht☹
	I don't understand.
Pilar von W.:	****Entschuldigen ich habe *ein Irrtum gemacht, ich meinte Strudel. Versteht ihr?***
Silvia R.:	Apfelstrudel??
	Applepie?
Silvia R.:	*Ja, * jetzt ich verstehe.*
	Ok, now I can understand.
Silvia R.:	Entschuldigung.
	Excuse me.

Extract 4 shows how a student, Silvia, uses the repetition modality repeating Pilar's erroneous output to negotiate meaning. Immediately after Pilar indicates Silvia that her output is wrong (explicit corrective feedback). Thus, in this brief extract example, we can observe both corrective feedback types: the implicit and the explicit one:

Extract 4: On-task negotiating meaning - type 2 (repetition)

Adelina C.:	Vorbereitung Weihnachten?
	Preparing Christmas?
Pilar von W.:	Ja, doch, ich habe Feiertag **und ich backe *Butterplatze für Weihnachten.**
	Yes, I have finished with my working day and I´m baking Christmas cookies.
Silvia R.:	**Du backst *Butterplatze?**
	*You are baking *Butterplatze?*
Pilar von W.:	**Weihnachtskeksen, also ich meinte Butterplätzchen.**
	Christmas cookies, I mean butter biscuits.

4.2.3 Negotiation Strategies in Off-Task Conversations

It was quite common for students to start off-task conversations throughout this project. The following extracts show examples of conversations where meaning negotiation occur. To begin with, extract 5 shows a student (Carmen) using the chat to address her interlocutors directly with a question about syntax:

Extract 5: Off-task negotiating meaning - type 1 (clarification request)

Susanne I.:	Hallo Emilio! Toll wieviel du geschrieben hast, nur zwei kleine Fehler: ihren Fabriken und heißt Schwäbisch Hall??
	Hey, Emilio! Good that you wrote so much, just two insignificant corrections: […]
Carmen P.:	**Hallo Suse! Ich verstehe nicht warum benutzt du die inversion hier "Toll wieviel du geschrieben hast"!**
	Hey Suse! I cannot understand why you use here the inversion:[…]

In the next extract the corrective feedback appears again in form of repetition, Sandra repeats Sergio's erroneous output and finally Sergio contributes to the conversation again using the correct form and modifying his error:

Extract 6: Off-task negotiating meaning - type 2 (repetition)

Sergio A.: Ich bin auch Lehrerin aber von Musik für Kinder.
I´m also a teacher (female), but I teach music to children.
Gizane S: Oooooohhh. Ich spiele die Gitarre.
Oooh! I play the guitar.
Gizane S: **Sergio, du bist Lehrerin??. Ich bin Lehrerin aber ich bin Frau!**
Sergio, you are a teacher (female)? I'm a teacher (female), but I'm a woman.

All these extracts illustrate how students succeeded in negotiating meanings using the WhatsApp tool. We can also see how the written chat assumes some of the functions that paralinguistic cues or body language have in face-to-face contexts: students succeeded also interacting in the socio-affective level. The examples show that the students use the written chat to contribute to the language learning activities (co-constructing knowledge), but also supporting one another and building relationships in the group, as shown in the next extract:

Extract 7: Students interaction at the socio-affective level

Guadalupe P.: Diese Sprache hat sehr lange Worte !!! ☹
This language has very long words !!! ☹
Guadalupe P.: Keine Panik,Silvia?
Don't panic, Silvia.
Silvia R.: Ja, keine Panik Lupe.
Right, Don't panic, Lupe..
Silvia R.: Alle den Tag ein bisschen.
A little bit everyday.
Silvia R.: Und in einem Monat sehen wir.
And let us see in one month.

These extracts illustrate some trend towards group solidarity. Several linguistic choices appear through the chats aimed at reducing social distance and emphasizing group membership.

4.2.4 Language Use

The qualitative observation of the chats throughout the project shows an overwhelming use of German from start to finish. Students encourage writing in German, despite their very limited knowledge. The language used shows a mix of features drawn from prototypically spoken and prototypically written media, however, the trend is towards a more informal, "spoken" style of writing. This is especially obvious at the paralinguistic/graphic level, where additional means have been used to represent effects that are possible in face-to-face interaction but not in writing.

Extract 8: Linguistic features – Orthography

The absence of capitalization (even with names and after full stop), is the most recurring feature concerning ortography, as shown in the following extract:

Ann Ch.: Ich muss meiner **tocher** helfen. *guten **abend.**
*I have to help my daughter. *good evening.*

Extract 9: Linguistic features – Vocabulary

As for the type of lexicon employed, the use of interjections is very remarkable, even though stutents encouraged using a formal register. The next extract shows also how students combine sometimes German and Spanish to be undertsood:

Pilar von W.: helfen??
help you?
Guadalupe P.: Möchtest??
"Möchtest"
Guadalupe P.: **Signifikat?**
Meaning?
Guadalupe P.: ??
Pilar von W.: **= quieres**
= you want
Pilar von W.: Ja, es ist sehr schwer
Right, it is very difficult.

Extract 10: Linguistic features – Paralinguistics and Graphics

In the chats we could find mixed patterns which combine spaced letters, multiple letters and alternative markers for emphasis, capitalization ("shouting"), little or excessive punctuation and emoticons.

Elena M.: Heute *ich koche Lachs zum Abendessen.
Today I'm cooking salmon for dinner.
Elena M.: *Grillen Lachs.
Grilled salmon.
Héctor N.: **Mmmm, lecker ☺**
Mmmm, tasty ☺
Elena M.: ich hoffe **doch?????**
I hope, ***don't I????***
Gizane S: Heute **KOCHE ICH !!!!**
Today ***I'M COOKING[4]!!!!***
Elena M.: **Danke!! Danke Gizzi ☺**

Extract 11: Linguistic features – Discourse and Text

Students used very frecuently interaction features (e.g. questions) and reproduced the most extended WhatsApp language pattern: short consecutive messages sended by the same interlocutor. Like in oral conversations the student tries to keep the interlocutor's attention sending strings of short messages:

Laura M.: Was studierst du?
What are you studying?
Sandra Ch.: Wer, ich?
Who? Me?
Sandra Ch.: Ich studiere in Spanische Philologie UNED.
I'm studying Spanish Language Studies at UNED.
Sandra Ch.: Ich studiere in der Amtssprache Schule Deutsch????
I'm studying German at the bussiness schoool.

5. DISCUSSION AND CONCLUSIONS

This paper has presented an analysis of the results of a research project involving social interaction via Whatsapp, used by Spanish students of German from a (quasi-)beginner's level university course. After explaining the context and parameters of this learning experience and the methodology followed, an analysis of the results was undertaken in terms of student response, attitude and participation and also of the meaning negotiation strategies and language use. The high participation level demonstrated the degree of motivation of students to use this mobile technology for their language studies. The concentration of messages on working days and at the typical working hours within the day showed that while students were highly motivated, they were fully aware of the educational nature of the messaging activity. As in all working groups, there was a slight initial dropout of students, while the participation of the majority was rather similar and sufficient to provide critical mass to undertake an optional and open learning interactive activity between a small number of individuals.

[4] Here Gizane tries to emphasize Elena's error with capitalization.

The experience undertaken shows that using Whatsapp for foreign language learning is an effective strategy for a number of reasons. Firstly, students did noticeably improve their meaning negotiating skills and, despite their many fundamental linguistic errors, were able to understand and make themselves understood at all times. Secondly, they also reduced to some extent the amount of language mistakes (lexical, morphological, and syntactic) in an example-based rather than prescriptive manner (error correction was reduced to a minimum). Thirdly, the students declared and demonstrated that they had found this (optional) activity to be highly enjoyable and specifically asked the teacher for similar initiatives in the forthcoming courses. Using Whatsapp for teaching a foreign language made the teacher change her usual roles as corrector and feedback provider into more challenging ones where she had to skillfully drive students toward certain topics of discussion and types of discourse, and provide native-like language models, in an indirect way. Also, the usual error correction and feedback were substituted by more subtle forms of eliciting student awareness, which were generally grasped by the student in question.

The authors claim that the evidence provided by this piece of research adds up to the successful undertaking of a number of related experiences, proving that it is also effective with old students and in a distance-learning higher education context. We believe that the Whatsapp technology is particularly adequate for beginning learners of any foreign language, given the direct correspondence between the style, length and complexity of the messages typically sent in this technology and the style, length and complexity of the messages they are able to produce themselves. It will be interesting to explore how generalizable and scalable this is in future work.

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STUDENT PREFERENCES FOR M-LEARNING APPLICATION CHARACTERISTICS

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ABSTRACT

This study attempts to find out students' expectations from mobile learning (m-learning) applications. The relationship between students' grade levels (freshman, sophomore, junior, senior) and their preferred m-learning application characteristics were analyzed. A questionnaire on students' preferences in m-learning applications was used as the data collection instrument to 78 undergraduate students in a public university to 3 majors namely IT, Computer and Electronics engineering during summer 2013 semester. ANOVA analysis was used on the collected data. The results showed that the availability and easy usage of mobile applications are among the most preferred characteristics of applications. Surprisingly, entertaining feature was the least expected feature by students. In general, there was a differences among students' perception related to their expected educational m-learning applications considering their majors and school experience.

KEYWORDS

m-learning application characteristics, student preferences

1. INTRODUCTION

Rapid growth of technological devices and informatics technologies and their use in diverse fields motivate and help educators to use them in their instructional designs as learning enhancement tools. Consequently, traditional educational methods are replaced with new technology-enhanced learning environment with bringing improvement to the existing e-learning strategies (Korucu & Alkan, 2011).

The fast-pace life style of 21st century requires individuals to use diverse technological devices especially mobile ones in their daily lives. Consequently, educational fields attempt to integrate and use the rapidly developed technology for enhancing learning process leading to emergence of the notion of mobile-learning. However, implementation and use of mobile applications require great care in design to satisfy the educational needs. Ally (2009) point out that mobile learning looks for carefully consideration of various aspects such as hardware and technologies, pedagogical perspectives and other characteristics. Portability, immediacy, individuality, connectivity and accessibility are among the important features of mobile devices which in center of m-learning. According to Sharpless (as cited in Park, 2008) these innovative technologies advocate m-learning to access contents easily and outside of the classroom. The idea on focusing on the importance of learning outside of the classroom is supported in literature Eliasson, Knutsson, Nouri, Karlsson, Ramberg and Pargman (2012) stating that " one of the most promising arguments for introducing mobile devices to learning is to provide students with opportunities to learn outside the classroom, with direct access to contents and contexts relevant to the learning goals." (p.92)

In m-learning, one has the opportunity to use a computer like smart device anywhere and anytime. Wagner (as cited in Park, 2008) believed that technologies look for essential factors for accomplishing its purposes such as technology readiness in terms of learning. Readiness of learners is categorized into two: (i) readiness of changes acceptance and (ii) readiness for new learning innovation (Abas ,Peng & Mansor , 2009). Students readiness for technology usage and m-learning investigated in literature by Kennedy, Judd, Churchward, Gray and Lee-Krause(2008), Abas et al. (2009). The studies by Jairank, Praneetpolgrang & Mekhabunchakij (2009) and Liaw, Hatla & Huang (2010) focused on the acceptance of mobile learning. In the study conducted by Jairank et al. (2009) the m- learning acceptance and influential factors of its usage in higher education in Thailand was considered. They used the TAM (Technology Acceptance Model) (Davis, 1989; Davis, 1989, 1992) and UTAUT model (Unified Theory of Acceptance and Use of Technology) by Venkatesh, Morris, Davis &Davis (2003). The results of their study indicate that the most referred three factors in m-learning were: (i) ease of use, (ii) capabilities of usage without time and place constrains, and (iii) it's interesting interface. It is noted that most of the participants ask for training in advance. Another important finding of the study was that the students' perceptions play an important role in designing m-learning system (Abas et al., 2009).

Some studies in literature point on the effect of m-learning to external and internal leaner characteristics and behaviors. Homan and Wood (as cited in Liaw, Hatala & Mei Huang, 2010) stated that the mobile devices have the potential for changing students' behaviors, interaction with each other and their attitudes toward learning. The role of mobile devices can be noted as a complementary approach for existing learning style. It is stated that m-learning theory expected to support learning which happen outside of the classroom and within individual's activity without interrupting them. (Liaw et al. , 2010). Moreover, the learned actions should consider psychological requirements such as: being meaningful and intelligent, operational with cognitive tools such as signs. The studies conducted by Weinbrenner et al. (2012) and Forbus, et al. (2008) emphasis on semantic interpretation of digital sketching and sketch understanding in terms of cognitive science and education respectively. (Park, 2008) studied the role of visualization in m-learning using cognitive learning theory which considers mental process of information transformation and explain the importance of pictorial instruction in terms of huge amount of information.

The study conducted by Liaw et al. (2010) reveals that four factors which increase the acceptance of m-learning systems are learners' satisfactions, learners' autonomy, powerful system functions and rich interaction and communication activities. Prensky (as cited in Kennedy et al. 2008) stated that new generation students are completely different from other generation in terms of using technology whom they refer as digital natives. Moreover, it is stated that the condition in which new generation are grown up has influenced their preferences and skills leading them to be prone to reach and access information quickly.(Kennedy et al. 2008) The research about students readiness for mobile learning in Malaysia Abas et al. (2009) demonstrated that while the majority of the students in OUM ("Open University Malaysia" the pioneer in the open and distance learning and the second largest mobile penetration in South East in Asia) were ready for m-learning, they were interested in the use of it for non-technical courses rather than for technical ones. However, the high usage rate of technology by students in their daily lives does not mean they use it for educational purpose .The study conducted by Caruso & Kvavik (as cited in Kennedy et al. 2008, p.3) reveals that "students are comfortable with basic set of technologies in their daily lives but are less comfortable with specialized technologies. "

In the case study conducted by Gil-Rodríguez & Rebaque-Rivas (2010) the relationship between mobile learning and commuting was considered for developing useful m-learning applications. The study revealed and confirmed the effectiveness of m-learning in terms of on-line education for commuters. Reading activities came out to be among the most referred ones done by students while travelling, so e -books could be useful tools for them. On the other hand, learners search for more flexible editing options which could enable them to underline part of text and take notes on the page while reading. Internet connections are basic needs for students so as provide facilities for emailing, consulting in forums and searching for information while commuting. Generally, type of contents and mobile application types need to be taken into account for students who commute regularly in daily scale. Various types of mobile learning applications such as ubiquitous and augmented game (Fotouhi-Ghazvini, Earnshaw, Robinson & Excell, 2009) using audio /video streaming and podcasting (Walls, Kucsera, Walker ,Acee ,McVaugh & Robinson, 2010 ; Mandula, Meda & Jain, 2012) for different fields of study such as language learning (Guerrero, Ochoa, Collazos 2010; Gromik, 2012), organic Chemistry instruction (Pursell ,2009), natural science courses (Jen Hwang, Wu & Ru Ke, 2011) have been developed recently according to learners needs and characteristics of diverse fields. Yarandi, Jahankhani& Tawil (2012) considering the importance of personalization in learning process proposed a model based on ontology emphasizing on learners abilities and preferences. Regarding the adaptive learning theory and item response theory, they provide combination of both in which personal capabilities are requirements for the selection of the next learning steps in mobile application design.

1.1 The Purpose of the Study

The importance of m-learning using various applications is among innovative concepts in terms of education. New generation which are known as "net-generation" explain their interests for online-learning and consequently m-learning. (Gil-Rodríguez and Rebaque-Rivas, 2010). Different studies such as Liaw et al. (2010) and Jairank (2009) about m-learning acceptance and influential factors emphasized on the important role of learners' attitudes in designing and developing m-learning applications. The result of the study by Liaw et al. (2010) noted learners' satisfactions as one of the increasing factors for more acceptance of m-learning applications. Therefore, analyzing learners' expectations from m-leaning applications can be noted as a crucial factor for developing more useful and easier m-learning applications. The suitable mobile applications from students' perspectives that can provide students expectation and match their requirements have not been fully considered yet. In this study, we attempt to find out students' perceptions about characteristics and features of m-learning applications from various aspects and explore their expectations from m-learning applications. The results of this study can provide useful and needed information for designing and developing more and easier accepted m-learning application. The questions that the study attempts to answer are:

1. Do undergraduate students' grade levels (freshman, sophomore, junior, senior) effect the type of their preferred m-learning application characteristics?
2. Are there significant differences among students' from different departments (IT, Computer and Electronic engineering) preferences in terms of m-learning application characteristics?

2. METHODOLOGY

This study attempts to find out students' expectations from m-learning applications in order to improve the m-learning application design and development process which possibly could enhance learning process and meet students' requirements. The role of students' departments and grade levels on their expectations from m-learning applications were analyzed. Survey research design was used in this study. The used data collection instrument, participants of the study and statistical analysis are represented in the following sections.

2.1 Instrument

Considering the study conducted by Venkatesh et al. (2003) and Liaw et al. (2010) which indicated that ease of use, interesting interface and rich interactions and communications as the important factors for acceptance of m-learning applications by students help us to develop the questionnaire for this study. Developed questionnaire included 30 questions that were divided into 5 subsections ,each of which considered specific feature of m-learning applications namely: ease of use (6 questions), collaboration (7 questions), entertainment (5 questions), educational (8 questions) and availability (4 questions). The questionnaire was scored based on 5 points Likert scale (Strongly agree, Agree, Neutral, Disagree, Strongly Disagree). In order to check the validity of the questionnaire, subject expert opinion was collected. Furthermore, a pilot was conducted and data collected from 23 undergraduate students of 3 departments (Information technology, Computer and Electronic engineering) with age range of (20- 29) who study in different grades was analyzed. The calculated Cronbach's $\alpha = 0.76$ based on 78 returned the questionnaire from undergraduate students.

2.2 Data Collection and Analysis Method

The data was collected from 78 Iranian undergraduate students (41 female and 37 male) who study in three majors namely: IT Engineering, Computer Engineering and Electronic engineering with age range of 20-29 ($M = 22.99$, $SD = 2.07$) using developed questionnaire. Descriptive and inferential statistics was used for analyzing the data using SPSS. One-Way Analysis of Variance (ANOVA) was applied in order to find out the difference between students' expectations from various features of m-learning applications and their majors and grades. In addition, Pearson Correlation Coefficient was used for analyzing the relationship between students' expectations and their ages.

2.3 Results

In order to answer the first and second question of the research regarding with learners' perceptions on m-learning applications first data from participants in different departments was analyzed. The results of descriptive statistics indicate that the availability (*M* =.94 , *SD* =.14) and easy usage (*M* = .82 , *SD* = .17) of m-learning applications are among the most preferred characteristics for m-learning whereas entertainment (*M* =.55 , *SD* =.22) is the least expected types of m-learning applications by learners depicted in table 1.

Table 1. Means of students' perceptions on M-learning applications

M-learning Application Feature	M	SD
Ease of use	.82	.17
Collaboration	.87	.14
Entertainment	.55	.22
Learning	.88	.16
Availability	.94	.14
Total	.81	.22

One-way ANOVA tests show that students' preferences are approximately similar to each other about various types of m-learning applications based on their majors. However, there is a difference between students' preferences $p<.05$ related to educational m-learning applications based on their majors as it is shown in table 2.

Table 2. One-way ANOVA results for students' M-Learning preferences among departments

Sources	*Groups (Students of IT, Computer, Electronic Departments)*	*df*	*F*	*P*
Ease of use	Between Groups	2	3.09	.05
	Within Groups	75		
Collaboration	Between Groups	2	1.59	.21
	Within Groups	75		
Entertainment	Between Groups	2	.07	.93
	Within Groups	75		
Educational	Between Groups	2	7.07	.00[a]
	Within Groups	75		
Availability	Between Groups	2	1.95	.15
	Within Groups	75		

[a] P<.05

The differences between students' preferences in relation to educational m-learning applications could be explained with by the perceptions of IT and Electronic engineering students. Descriptive statistics shows that educational mobile applications are the most preferred once for IT students (*M* =.94, *SD* =.14), and Electronic engineering students are the group who prefer educational applications the least (*M* =.77, *SD* =

.20). Considering the effect of students' grade levels on their expectations, we attempted to analyze students' perceptions on m-learning applications who study in different grades (Freshman, Sophomore, Juniors, Seniors).

According to descriptive statistics, senior students are the one who prefer more educational mobile applications (*M*=.95, *SD*= .08) and educational applications are preferred the least with sophomores (*M* =.79, *SD* =.20).

Table 3. One-way ANOVA results for students' M-Learning preferences by grade levels

Sources	*Groups (Students' grades Freshman, Sophomore, Juniors, Seniors)*	*df*	*F*	*P*
Ease of use	Between Groups	2	1.74	.17
	Within Groups	75		
Collaboration	Between Groups	2	2.69	.05
	Within Groups	75		
Entertainment	Between Groups	2	.34	.80
	Within Groups	75		
Educational	Between Groups	2	6.44	.00 [a]
	Within Groups	75		
Availability	Between Groups	2	.74	.53
	Within Groups	75		

[a] P<.05

In order to check the relationship between students' ages and their preferred types of m-learning applications, Pearson Correlation Coefficient was used and it showed that there is a positive correlation $p<.05$, (r^2 =.27) between students' grade level and their preferences about easy usage of m-learning applications .

3. CONCLUSION AND LIMITATION

In a nutshell, this study aimed to find out learners' perspectives on m-learning applications in order to design required and desired mobile application. Students' opinions about various features of m-learning applications (ease of use, collaborative, educational, entertaining, availability) were analyzed using the developed questionnaire (Cronbach's α= .76). The number of returned questionnaires by undergraduate Iranian students were 78 who study in 3 majors (IT, Computer, Electronic engineering) in summer 2013.The results of data analysis indicated that the availability and easy usage of mobile applications (*M* = .94, *SD* =.14) and *(M* =.82, *SD* = .17) were among the most referred characteristics of required applications respectively.

The results of this study depicted that the easy usage (*M* = .82 , *SD* = .17) of m-learning applications is among the most preferred characteristics of m-learning applications by students. similar outcomes were found in the case study by Gil-Rodríguez and Rebaque-Rivas (2010). The study indicated that while commuters were satisfied by some of the m-learning applications such as e-book, they looked for more flexible applications that can enable them to perform more regular tasks such as taking notes or editing options while studying. Their study depicted the importance of user-friendly features for mobile applications from learners' perspectives as the result of the current study. The current research shares also similar results with the study by Jairank (2009) in Taiwan which indicated that ease of use was among the factors which increases the acceptance level of m-learning applications in higher education. To our surprise, entertaining feature (*M*=.55, *SD*=.22) was the one which expected the least by students.

In addition, the results of the study revealed that educational mobile applications are the most expected types of applications by undergraduate students. On the other hand, the study by Caruso & Kvavik (as cited in Kennedy et al. 2008, p.3) pointed out that "students are comfortable with basic set of technologies in their daily lives but are less comfortable with specialized technologies."

There was a difference among students' perceptions related to their expected educational m-learning applications considering their majors and grades. Descriptive statistics shows that IT students (*M* =.94, *SD* =.14) prefer more educational applications in their mobile devices and Electronic engineering students are the group who prefer educational applications the least (*M* =.77, *SD* = .20). Senior students (*M*=.95, *SD*= .08) are the most interested group in educational mobile applications while educational applications are preferred the least with sophomores (*M* =.79, *SD* =.20) as well. The findings of the study can shed light on the path which we need to take for designing more useful and easier m-learning applications. Students' majors that are limited to 3 specific engineering fields and short research span which lasted only for summer school can be noted as the constrains of the study .

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LEARNING AND TEACHING WITH MOBILE DEVICES AN APPROACH IN SECONDARY EDUCATION IN GHANA

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ABSTRACT

While many developing nations find Internet-based e-learning unsuitable for their needs (lack of technology as well as of accessibility), mobile learning methods – specifically those involving the use of mobile-phones for both formal and informal learning – hold great promise for them (Grimus et al, 2013b). This article examines the chances and challenges of the use of mobile devices to support improvement and transformation of education in a Senior High School in Ghana. It draws attention to the local situation in a field-study looking at infrastructure, development of material and support. A model for teacher training was designed to facilitate teachers' attitudes and abilities for implementation of mobile learning. The article figures out how mobile devices can be integrated in learning and teaching on the specific background of a school in Ghana. Based on our results we conclude that teachers and students want to use mobile devices in learning. Their perceptions are positive and they developed courses for specific subjects available for eReaders and mobile phones. The results and feedback from two workshops encourage us to propose this model as an example for integration of mobile devices for learning in other regions of Sub Sahara Africa.

KEYWORDS

Mobile devices, didactic potential, content-creation for small screens, collaborative learning.

1. INTRODUCTION

Although the education system in Ghana has witnessed various policy reforms with the aim of ensuring universal access to improved quality education for all children it is evident that progress towards the implementation of ICT in education in Ghana has been slow for several reasons, e.g. high cost of information and communication infrastructure, lack of technical expertise (UNESCO 2012, Grimus et al, 2013a) There is growing concern in Africa about the use of computers to support learning, but the general state of pedagogical integration of ICTs in Ghana is low (Yianda, 2010) 'Computers and mobile technologies are revolutionizing what we know and how we know it, and hence what we learn and how we can learn it'… 'we should however be careful not to obscure the nuances and differences between individual devices and technologies and the various ways in which different cultures and societies adopt and adapt them'. (Traxler, 2010, p.15) Traxler points out that ethics, behavior, fashion and language are expressions of identity, community and nature and the use of mobile devices has therewith an increasing impact with implications for the working of education institutions. (Traxler, 2010, p.9)

The general idea of the study is to explore how secondary education in Ghana can benefit from new developments in mobile technologies together with new didactical approaches. (Huber, 2012) A research project was designed to help teachers at Senior High Technical School in Ghana to use ICT for professional development (1st workshop) and to develop content for mobile learning with teachers and students in a follow-up event (2nd workshop). The aim is to provide students a possibility to access learning material on their own mobile phones whenever they demand it and to produce content particular to local demands. Mobile phones use a small screen and are limited as an input medium. This makes structuring content even more important (Huber and Ebner, 2013). Delivering knowledge 'chunked' means that content is structured and connected in very different ways from common lectures and books. (Traxler, 2010, p. 14)

The project is designed on small scale, based on the environment and specific needs of the school in Keta. It runs without external funds, but has a strong focus on the practicability in the field. The overall research goal is to develop a model for integration of mobile devices at Keta Senior High Technical School in Ghana, to empower teachers to activate similar adoption in other schools.

2. METHODOLOGY

Objectives of the research: The study tries to carry out on-site conditions for using mobile technologies for teaching and learning in Ghana. The major research questions are defined as following:

1. How can mobile learning strategies be implemented in the field?
2. How can this experiences help for further strategies on learning and teaching in Sub Sahara Africa (SSA)

Therefore the study looks in particular to following areas:

- How can teachers contribute to implement mobile learning?
- Preconditions and necessities to be addressed to enable mobile learning.
- Can access to digital content be improved by using mobile phones?

Research Methods: The research work was conducted as an on-site field study with qualitative interviews and quantitative questionnaires, carried out during two workshops (September 2012 and 2013) for teacher-training in Keta, Ghana, at Senior High Technical School (KETASCO, http://ketasco.com/). Data collection was executed in two cycles (anonymously).

- Online-surveys: In September 2012 only teachers from Keta region participated, in September 2013 teachers and students from the school took part.
- Post-workshop-feedback (surveys after both workshops).

3. RESEARCH STUDY

The school is expelled in rankings for a high standard of education, looks back to a long tradition, and is participating in different competitions in the country (e.g. sports, robotics). The campus (boarding school) is situated close to the sea and Keta Lagoon in the south of Ghana, hosting a Junior and a Senior High Technical Secondary School (SHSS) with about 2.800 students and 101 teachers. Each class holds about 40-60 students. Most of the students of SHSS, aged 15-20 years, live at the campus, so do many of the teachers, which provides the chance of informal contact of students and teachers besides school time.

From a technical perspective there is one computer-lab (about 15 PC's, WLAN and a projector) with MS Windows as operating system and MS-Office on board. Internet is only available in the computer lab and the bandwidth is low, which causes problems when more persons try to connect to the Internet at the same time; the connection is unstable.

3.1 Research Study 1: Basic ICT-Skills for Teachers- Digital Literacy for 21st Century

The 1st Workshop was scheduled for two weeks at the end of school vacation in September 2012 (10 days, 50 hours). At that time final exams are finished, teachers are available without competing lectures. A government program was put into place just few months ago, where teachers were given laptops for free; the timing fit nicely with the project.

Aims of the workshop: The main objective of the workshop was to equip teachers with computer and Internet-skills to integrate digital media in teaching and therewith to support the learning and teaching process. New didactical approaches and methods should be developed, adequate to environment and culture of the region, as well as learning material for this purpose. The workshop addressed the use of digital technology and communication tools in teaching, pedagogical aspects, and to enhance personal skills in digital literacy. The course focused on motivating teachers to explore new methods in using office-tools, e.g. presentations: structuring text, visualization by integration of images, diagrams and tables, to explain facts offered otherwise mainly in textbooks and photocopies, or even only available in one book on the table of the teacher.

Topics of the workshop:

- Pedagogy and didactics: How to enhance teaching and learning by using ICT for preparation and in class teaching. Integration of collaborative learning by using digital devices in subject-teaching.
- Computer- and Internet-skills to develop learning materials, presentations, assessments.

- Integration of presentations in class-teaching: layout of worksheets and posters (structure, integration of tables and images), spreadsheets (visualizing data in diagrams).
- Evaluation of open online resources (OER)
- Link-lists for self-conducted learning
- Development of a digital portfolio as an example to recap learning outcomes.

Participants: The workshop was designed to take 15 teachers who are encouraged to pass their learned skills on to students and colleagues afterwards. For registration the teachers completed a pre-training survey (basic computer-skills, subject of teaching, expectations of the training). Teachers of KETASCO were addressed as the main target audience, finally few teachers from other schools participated. Two thirds of the teachers used their personal laptops, half of them were the donations of the above mentioned 'free laptop for teachers' project.

3.2 Research Study 2: 'Teach to Learn – Learn to Teach'. Integration of Mobile Devices to Improve Learning Outcomes

The outcome of the first workshop together with the discussions at the ministry of education for further developments in education in Ghana ended up in the decision to continue the project with a follow-up workshop. For the second workshop a better infrastructure was proposed. An extension of the course should allow more time for individual projects and practice. The 2nd Workshop was scheduled with duration of three weeks in September 2013, 60 hours course-lessons and additional guided practice: 10 days teacher training, 5 days (third week) students and teachers work together; practical issues.

The workshop focused on learning and teaching with integration of mobile devices, addressing the development of digital content and guidelines for best practice. 'Mobile devices affect many aspects of the process by which knowledge, ideas, images, information and hence learning are produced, stored, distributed, delivered and consumed'. (Traxler, 2010, p.13) Low cost and affordable mobile phones in Africa are developing a new conduit for learning. Instructional design suitable for desktop computers does not transfer well to mobile phones. (Batchelor, Botha, 2009) To elaborate on a topic a deeper insight may be gained by creation of micro-content, e.g. adjusting material which is available online or in books for local demands, integrating images, figures and graphs. Ethics and cultural aspects gained during the first workshops were considered.

Aims of the workshop: Teachers integrate learning with mobile devices at Senior Technical High School to improve learning outcomes. With regard to the didactic and pedagogical potential the creation of digital portfolios, presentations and content-chunks leads to self-directed learning, learning by doing and by experiences. Teachers are encouraged to transfer their new didactic/pedagogic insights to students and colleagues. This can shift teaching methods to more efficiency in knowledge-achievement and learning.

Topics of the workshop:

- Didactical methods: Evaluation of digital learning material e.g. Open Content, OER; Licenses; Creative Commons; Simple English Wikipedia, etc. and possibilities for integration in teaching.
- Creation of locally relevant digitized content for subject-teaching; upload of micro-content (epub, pdf) to mobile phones.
- Integration of collaborative mobile learning methods: Cloud (drop-box) for micro-content development, feedback and reviews.
- Hands on: Development of a personal digital portfolio; specific tools, e.g. ABC platform for transformation of content into eBooks: https://ebook.tugraz.at/ (Nagler et al., 2012), test of output with mobile phones (NOKIA E5-00) and eReader; peer-review.
- Guidelines: 'Best practice – mobile devices for learning'.

Participants: 20 teachers from KETASCO registered for the course (basic computer and MS-Office-skills were requested, a personal laptop appreciated), in the third week additional 13 students participated fulltime, while 5 teachers had left the course. A student of KETASCO assisted in technical and organizational aspects, his support was highly appreciated and contributed to the success of the workshop.

4. RESULTS

4.1 General Results

Pedagogy: Different methods of pedagogy in class teaching (Ghana / Europe) were figured out. In Ghana methods of teaching are dominantly frontal; memorization of text is common practice. Even in SHSS ICT is only taught in specific ICT-classes, tests in ICT are carried out in paper writing. The results of the online-surveys during the two workshops indicated that mobile technologies and digital devices are rarely used in educational context so far.

It can be pointed out that teachers highly appreciated methods of group work and cooperation, which they experienced during the workshops (see feedback of the workshops in 4.2 and 4.3). Peer-review and different modes of interaction were also introduced in the courses.

Infrastructure: Frequent power outage impairs the work in the computer-lab (PC's and router).

Online Survey: With regard to the online-surveys it has to be mentioned that in September 2012 only teachers participated in the survey, while in 2013 teachers and students were encouraged to participate. Although the numbers are low the percentage is given in addition, to allow easier comparison of the results in the specific groups. In table 1 and table 2 data of ownership and types of different devices are figured out.

Table 1. 'Which of these devices do you own?'

	Teachers 2012		Teachers 2013		Students 2013	
Ownership	n =36		n=18		n=43	
Mobile phone	31	86%	17	94%	40	93%
Computer (desktop or tower)	20	56%	9	50%	13	30%
Laptop or Netbook	27	70%	12	67%	15	35%
Tablet	5	14%	2	11%	2	5%
Digital Camera/Video	14	39%	4	22%	5	12%
Other (Kindle, iPod)	2	6%	3	17%	4	9%

Table 2. 'Which type of mobile phone do you have?'

	Teachers 2012		Teachers 2013		Students 2013	
Type of mobile phone	n =31		n=17		n=40	
Smart-phone	15	48%	8	47%	15	38%
Feature-phone	4	13%	2	12%	9	23%
Common (basic) mobile phone	12	39%	7	41%	13	33%
Don't know	0	0%	0	0%	3	8%

As it is seen in table 1 and 2 there is only a slight difference in the data of teachers in year 2012 and 2013. While ownership of mobile phones of teachers and students show nearly similar high rates there is a considerable difference with regard to the ownership of computers and laptops or notebooks. Furthermore it is from interest that only seven teachers (56 in total) do not own a computer or laptop, compared to another ten having at least more than one. In contrast only about one third of the students own a computer, another third a laptop. It is definitely possible for the majority of teachers to develop content with a computer or laptop, while most of the students have access to it when it is available on mobile phones. Mobile devices allow to access content even during power-outages. Table 3 shows teachers' and students' possibilities of Internet access with mobile phones.

Table 3. 'Do you have Internet access with your mobile phone?'

	Teachers 2012		Teachers 2013		Teachers total		Students 2013	
Availability of Internet-asccess	n =31		n=17		n =48		n=40	
Yes, always	24	77%	11	65%	35	73%	31	77%
Yes, but only when Wi-Fi is available	4	13%	2	12%	6	12%	4	10%
No, can't access the Internet	3	10%	4	24%	7	15%	5	13%

In table 3 a difference to access the Internet with mobile phones can be pointed out only in the small group of teachers in September 2013. This may be due to the small number of the sample, but looking at the total numbers of teachers and students no significant difference can be figured out: 85 % of teachers and 87 % of students can access online content at least when Wi-Fi is available.

4.2 Research Study – Workshop 1

Outcome: The first workshop addressed basic ICT literacy with a focus on pedagogy. Although the participants had answered a pre-questionnaire with regard to ICT skills it turned out that this ranged from difficulties in saving a file to basic skills in video-editing; most common was text-processing and use of Facebook. Few teachers expressed the use of www for preparation of their lessons to some extent. All teachers used mobile phones for phone-calls, although most of them could access mobile Internet only few used it. As a possible reason was figured out that less than a third were familiar with basic Internet skills. It was difficult for them to create a portfolio, to extract keywords from a presentation or to formulate short statements on ICT related topics with own words. Finally 14 teachers fulfilled the requirements (course-attendance, portfolio, worksheets and presentations) and received a certificate for successful completion.

The ***course-feedback*** was targeted to how the workshop changed teachers' views of teaching in classroom practice. They were asked to review on how they have benefited by improving ICT-skills and didactical methods. Unfortunately a virus-attack followed by power-outage did not allow saving the feedbacks on pen-drives, only three of private laptops could be received. Some statements with regard on teaching are given as examples: '… can offer better guidance to my students and on how to use search engines and ICT tools more effectively', '…integrate the new skills in subsequent teaching: how to produce better documents in Word, Powerpoint and Excel to meet professional standards and to improve learning outcomes', 'the use of digital literacy methods in teaching would have positive impact on the cognitive and affective domains of the learners'.

In a follow-up ***online survey*** concerns of teachers' perceptions towards future developments for learning with integration of mobile devices were requested. A five-point Likert-Scale is preferred for the reactions of the perception in the research. For each of the statements there is an obligation to be classified with one of the five categories: I strongly agree / I agree / neutral / I do not agree / I strongly disagree. The answers gathered were graded between 1 and 5 points, giving five points to category 'I strongly agree' and one point to the category 'I strongly disagree'. The average gives an overall perception of the item specified.

In table 4 teachers' perception of having material available on an own mobile device are given, on similar questions for teachers (T) and students (St): 'Would you agree that having course material available on your mobile device would be beneficial for teaching?' (T) …..'would be beneficial for the learning process?'(St)

Table 4. Comparison: Teachers and students perceptions of course material available on mobile devices.

I strongly disagree		I disagree		neutral		I agree		I strongly agree		Answers total		Course material	Average	
T	St	T	St	T	St	T	St	T	St	T	St		T	St
1	0	0	2	1	3	8	14	19	12	29	31	Slides	4.52	4.16
1	0	0	0	3	2	5	16	19	13	28	31	Lecture Notes	4.46	4.35
1	1	0	3	3	3	9	11	15	11	28	29	Quizzes	4.32	3.97
1	0	0	1	2	1	9	16	15	10	27	28	Link-List	4,37	4,25
1	0	0	1	4	2	8	14	16	13	29	30	eBooks	4.31	4.30

The findings can be interpreted that both, teachers' perceptions (average 4.4 points) as well as students (average 4.2 points) towards availability of different course material on mobile devices are highly positive. The result shows clearly that banning mobiles at school – which is common state – cannot be a realistic long-term solution.

Challenges: Infrastructure and equipment in the computer-lab did not meet the expected requirements: Frequent power-outages and lack of Internet-connection heavily affected the workshop. This was also the mostly complained issue by the participants. The PCs' were not well maintained and full of viruses; due to disconnection of the Internet no updates were possible. Hence the proposed topic 'Basic Internet-skills and best-practice – Internet for learning and teaching' could not be performed to the extent as planned: It was not possible to address main topics of the course-curriculum without Internet, thus some of the proposed activities had to be cancelled (evaluation of OER with regard to local demands; upload of micro-content; installation of free software).

After the workshop a meeting was held at the Ministry of Education in Accra with a delegate of the ministry, the headmaster and two teachers. The outcome of the workshop was discussed and a continuation of the project was proposed. Support of service and substantial improvements with Internet-connectivity were promised for the follow-up workshop, installation of solar-power and improvement of Wi-Fi-connectivity were discussed.

4.3 Research Study – Workshop 2

The second workshop focused on preparing teachers to understand how mobile technologies can be incorporated effectively into teaching and support students' learning. To overcome the challenges recognized in the first workshop the second workshop was developed to focus on learning and teaching strongly by integration of mobile devices. In the second workshop it was recognized that a lot had changed in teaching after the first workshop: Teachers were more open-minded to new teaching methods.

For testing 20 mobile phones (second hand Nokia E5-00 smart-phones, 256k display colours, 10 days standby, Micro-SDHC 2GB included inbox) and 5 eReader (TrekSTor E-Book Reader Pyrus mini, 4,3" Digital Ink) were brought from Europe, together with an additional WLAN router to support mobile Internet access.

Outcome: Based on the experience (power-outages) during the first phase of the workshop the need of flexibility in planning lessons was clearly recognized. Teachers were open-minded to learn about benefits and practiced new didactical approaches by using mobile devices.

In order to rethink methods of learning and teaching the following thesis was proposed**:** 'In five years all textbooks in Ghanaian Senior High Secondary Schools (SHSS) are provided as eBooks. Discuss in groups (2-3 teachers) possible consequences for a) teaching, b) learning, c) schools!' The outcome was presented as posters on paper, due to power-outage at the time.

Students were introduced by teachers in creating a digital portfolio and use of a drop-box. The importance of development of guidelines by teachers together with students was clearly identified.

A final (anonymous) evaluation on three main issues, executed by four external examiners (teachers from other SHSS), approved the success of the course, the quality of the material developed, and gave positive feedback to the participants.

- Teachers portfolios: Assessment on the quality of reports, structure, achieved learning outcomes, keywords, take-home-statements and summary.
- Course-units developed by teachers and students (small groups, 1-2 teachers+ 1-2 students); specific topics, available on mobile devices. Assessment of course-structure, -design, appropriate for small screens, patterns of visualization, e.g. images.
- Guidelines – Best Practice-Posters. Assessment checked on completeness.

Courses were developed on the topics 'Classification of Computer Hardware, Adolescence Pregnancy, Atomic Bonds, Adolescence Chastity, Projectiles, Projectiles, English Nouns, Law of Agency, Elements of Design, Demand, SET Theory', just to name some. The screenshots below can give an idea of the eBooks. Image 1 illustrates the structure of a course-unit on the topic 'Classification of Computer Hardware' and shows the associated task. In image 2 the learning objectives of the course-topic 'Atom Physics' are displayed.

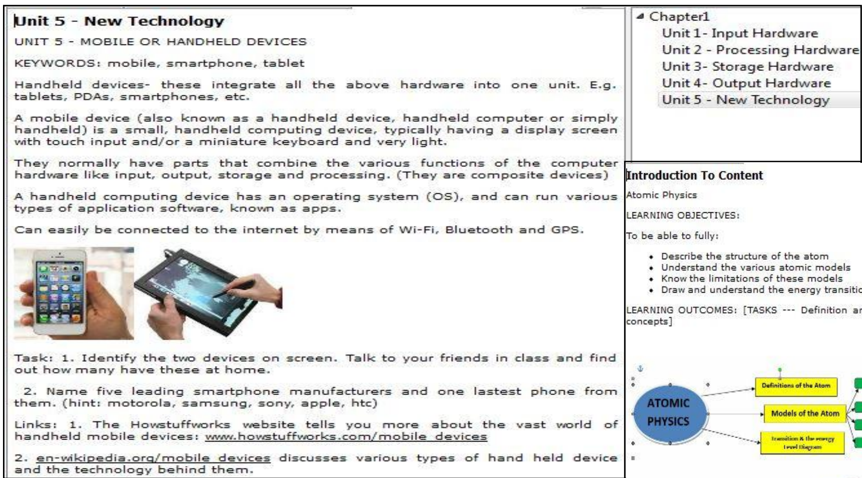

Image 1.
eBook :Classification of Computer Hardware.

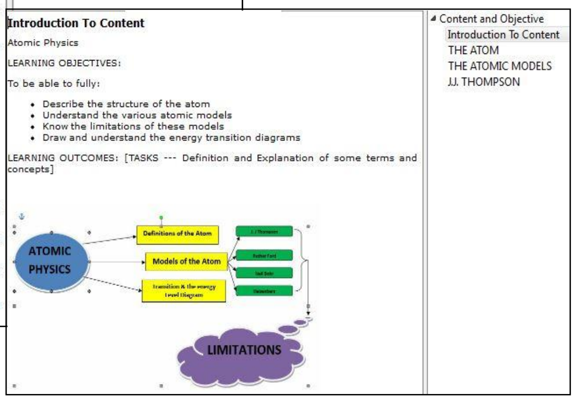

Image 2. eBook: Basics of Atom Physics.

The course-feed-back to included 13 items for students and 15 for teachers. It was planned as online-survey, but due to power-outage it was conducted on paper. In table 5 examples of answers to open questions are given.

Table 5. Specific issues were questioned, answers of students and teachers.

Teachers (n=12)	Students (n=13)
Comments: Benefits	
Ten teachers reported 'new ideas for teaching'; 'appreciate the practical part and activities, teamwork'; 'appreciated working together with students; 'benefits for learning by integrating what I have learned in the workshop'.	'learnt that I can use my mobile phone for more than just for gaming'; 'realized that I can do much more with my mobile'; 'makes learning easier'; 'can get more information on my own without having to contact my teacher'; 'easier sharing information with friends and teachers'; read eBooks'. 'aids my study-plan, getting information quick'.
Comments: Challenges	
'poor' Wi-Fi availability, 'devices and Internet-connectivity – costs; 'lack of mobile devices and infrastructure' ; 'students are not allowed to bring mobile phones to class'.	'mobile devices at school are not allowed' (5 x), disruptive attention in class', 'rules need to be changed'.
Individual knowledge of 'how can mobile devices benefit in teaching and support students' learning'	
Before / after workshop: poor 4/ 0, fair 4/ 0, good 4/ 8, excellent 0/ 4.	*Before* / after workshop: poor 3/ 0, fair 9/ 0, good 1/ 4, excellent 0/ 9.
Comments: Like best'	
'practical aspect, hands on'; 'new methods of learning and teaching'; 'interactive nature of the workshop/ group work'.	'built new student-teacher- relationship'; 'practical aspects'; 'creating own content and presentations'.
Free comments	
'program should keep running'; 'opened my eyes to new ideas of teaching'; 'enhances teaching'; 'teachers need regularly continued professional development'; necessary for 21st century teachers', need more of it'.	Students expressed high appreciation of co-working with their teachers and creation of content and presentations together.
Comments to 'like least,' teachers and students*:* frequent power outages, Internet disconnection	

Teachers were asked about their knowledge of pedagogical and didactical methods to integrate mobile devices in teaching and learning before and **after** the workshop: Results: poor 2/ **0**, fair 6/ **1**, good 3/ **6**, excellent 1/ **5**.

In the *online survey* (September 2013) concerns of teachers' and students' awareness and perception of learning and teaching with mobile devices were questioned. Two teachers and six students reported the use of 'free mobile content available on mobile devices', while 13 (72%) teachers and 25(58%) students 'haven't used it, but would like to do so'. A similar question as in workshop 1 (Table 4) addressed preferences for different types of material for mobile devices: 'Do you agree that having course material available on your mobile device would be beneficial *for teaching*? (teachers, T), '*….for learning?* (students, St). The outcome is similar to the results of the previous year and indicates that all items are highly appreciated (all >4 points, max. 5): Slides are rated with 4.6 points (T) and 4.2 (St); Lecture Notes: 4.6 (T), 4.3 (St); Quizzes: 4.2 (T and St), Link-List: 4.3 (T), 4.2 (St); eBooks: 4.4 (T and St). For details of the evaluation-method see online-survey in workshop 1.

The requirements for the final certificate of the workshop included fulltime participation in the workshop, a digital portfolio and course-content on a topic of the curriculum of the subject taught at school, available on a mobile-phone and eBook. Finally 14 certificates were handed over to teachers by the headmaster in the general assembly during the opening ceremony, together with awards for the best three in each category: course-content, portfolio, guidelines for best-practice.

Challenges: The most unpleasant experience was the frequent power-outages and the restricted bandwidth (Wi-Fi). It caused timeouts and uncountable restarts, e.g. uploads to the ABC-system (online-system for developing courses and convert them to eBooks). Although mobile Internet was installed the connection did not supply sufficient performance necessary for working in parallel groups (Huber et al., 2008).

5. DISCUSSION

While computer-labs and desktop-computers are scarce in schools in developing countries mobile networks, mobile phones and now smart-phones have the potential to question new approaches to learning and teaching (Traxler, 2011). Mobile penetration compensates the lack of infrastructure, which offers the chance to provide on- and off-line content for learning and knowledge-creation, accessible with mobile devices.

Infrastructure: In contrast to Europe ownership of a laptop or computer is not common with students in Higher Secondary Schools, while mobile-phones are predominant (chapter 4.1, table 1). Frequent power-outages challenge learning-activities with computers. Internet in public schools is not usual, and if, it is only accessible in the computer-lab. Low bandwidth challenges teamwork in groups with timeouts in addition to power-outages. To avoid the problems by converting content to eBooks online, offline tools need to be installed.

Benefits: Incorporating students to create digital content together with their teachers has shown positive aspects with creative ideas in structuring content in 'chunks' for mobile devices. A drop-box was appreciated and frequently used as a tool for exchange and feedback. It is recommended to download content to inbox-SD Cards; Micro SD Cards in eBooks and smart-phones can hold a lot of content, hence learning material is available on mobile devices anytime. Mobile phones and eReader provide the opportunity to access content with mobile Internet or Wi-Fi in times of power off for a couple of days, while laptops have limitations due to the battery-life. It allows learning in the evenings, when students come together in their classes, without teachers, for individual learning in peer groups. A local mobile network could help with downloads to students' devices.

Pedagogy: In his publication at the conference on 'digital future' Traxler pointed out that 'mobile devices will soon support every pedagogic option including the didactic and the discursive, the individual learning and the social'. (Traxler, 2010) Frequent power outages require high flexibility - to switch suddenly from online research to tasks without computer/ Internet-access. At the same time it offers chances for more interactivity and group-work, for discussions and alternative tasks, even to get out of a class, take a photo with the mobile phone, relevant for the topic discussed or with respect to the local environment, and present it later to the audience.

To engage students in learning together with their teachers was experienced in the second workshop. Together they became familiar with creating digital portfolios and developing content for specific local demands, using a drop-box for cooperation and feedback. The courses created are contextualized and culturally sensitive. Students as well as teachers expressed high appreciation of co-working and inspiring interactions, which led to rethink the common tracks of learning and teaching.

Guidelines - Best practice: Schools worldwide have traditionally banned mobile phones in the classroom. According to the findings in the surveys it can be concluded that teachers' perceptions of integration of mobile devices for learning are positive. In the workshop they experienced benefits and challenges together with students and developed guidelines for 'good practice using mobile devices for learning'. The second workshop led to a better understanding of the issue than theoretical statements. A similar acceptance was found in the interview with the headmaster. In the opening ceremony of the new term the headmaster reported to all students and teachers about new trends coming up in education. He pointed out that this could help to become more critical thinkers, referred to new didactical methods and benefits by integrating mobile devices in learning and teaching. He proposed a reform of guidelines for use of mobile devices (mobile phones and eBooks) at school.

6. CONCLUSIONS AND OUTLOOK

The project in Ghana is on small scale and looks to develop a model for integration of new methods of learning and teaching with mobile devices. It was put in place to receive feedback on achievements and failures. The research provides first findings about teachers' perceptions towards activities using mobile devices in Ghana. Infrastructure and organizational aspects, chances and challenges were experienced in real environment. Main issues of the research were infrastructure, topics and content of workshops on teachers' professional development as a starting point for changes in education for the 21st century, where mobile devices play an important role in daily life and influence rethinking of methods and didactics of teaching. Content copied at school to Micro SD Cards integrated in mobile devices can help to avoid high costs for data access with mobile Internet. Although mobile Internet is slow and has low bandwidth mobile devices can be used to access content in clouds and during power outage.

We can conclude that teachers and students want to use mobile devices for learning. The perceptions are positive. Digital skills as well as didactical methods, necessary for developing content, were addressed, and as reported in the feedback, it can be resumed that the strategies were successful. The results can help to improve delivery of teacher- training and implementation of similar strategies in other schools in the region. Teachers are highly motivated to continue and build up a trainee group at school. At the time of writing a group of students has started with development of micro-content for mobile devices. They are tutored by the assistant, who supported the 2nd workshop and who is in close online contact with the course-leader. Together we will try to close the gap between the course in 2013 and the follow-up course in 2014.

The experiences from two workshops encourage us to propose this model as an example for integration in other regions of Sub Sahara Africa with similar environment and infrastructure, and where similar challenges can be determined. Teamwork with students offered new insights as well for teachers as for students and can be recognized as a basis for further developments in teaching and learning. We hope that the expertise gained in the workshops will affect further developments. To assure the continuation in the developments a further workshop is planned for 2014.

It can be resumed that teachers are starting to take advantage of the opportunities of mobile phones for learning. In summary it takes time for fundamental changes and developing new insights to change traditional ways of teaching and learning towards learning with mobile devices, but it has already started.

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CROSS-CULTURAL DESIGN OF MOBILE MATHEMATICS LEARNING SERVICE FOR SOUTH AFRICAN SCHOOLS

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ABSTRACT

In the era of mobile devices and services, researchers in the educational domain have been interested in how to support learning with mobile technology in both local and global contexts. Recent human-computer interaction (HCI) research in the educational domain has particularly focused on how to develop mobile learning services and how to evaluate the learning outcomes. However, learning occurs in a local cultural context and the impact of culturally sensitive issues of the design of mobile learning needs more attention. We studied mobile mathematics learning -service in a longitudinal research with over 30 South African schools during three years. Our aim was to understand culturally dependent issues which need to be taken into consideration in the design of mobile learning services. We found subjective and objective culturally dependent issues in the content, context, infrastructure and technology of mobile learning and therefore, subjects to cross-cultural research. In conclusion, we argue that localization enhances the user experience and therefore support learning.

KEYWORDS

Cross-Cultural Design. Mobile Learning. Cultural Context. Subjective and Objective Culture.

1. INTRODUCTION

Due to globalization and pervasive nature of mobile services, an increasing number of diverse users are able to take mobile learning services into use. Demand for fast development of mobile learning services poses challenges for designers. Sharples et al. (2010) stated that "children are developing new skills and literacies enabled by mobile devices, such as SMS texting, moblogging" and the m-learning development should be aware of the development. Motiwalla (2007) developed a m-learning framework for push and pull mechanism to be able to evaluate the personalized and collaborative content in m-learning applications. Moreover, Sharples (2009) outline methods for m-learning and present a socio-cognitive engineering approach (Sharples et al., 2002) to support design. Thus, recent research indicates how to support and evaluate personalized and collaborative m-learning. However, is this phenomenon similar everywhere from a global perspective?

The era of mobile devices and services has opened up a whole new way to learn to create possibilities for making information accessible for everyone and everywhere (Kukulska-Hulme et al., 2011). Nevertheless, the main focus of design and implementation of mobile learning services has been focusing on learners in western countries. In the study of cross-cultural patterns in mobile phone use by Baron and Segerstad (2010) it was pointed out that although contemporary mobile phone technology is becoming increasingly similar around the world, the cultural differences between countries may also shape mobile phone practices. Thus, to be able to understand how to design the m-learning services that fit the needs of different local learning contexts, more knowledge what are the typical practices for different cultures, is essential. The understanding of cross-cultural issues, e.g. what is valuable for the users (Cockton, 2008), in the design of technology supports the development of good user experience of mobile learning services in different local contexts. This is a vital issue when integrating mobile learning into the everyday processes of an ordinary school day in different countries with different cultural backgrounds. Research of cross-cultural issues in the field of human-computer interaction (HCI) has been focusing, for instance, on the design of web-pages for different cultures. However, there is not yet much research available of how mobile learning is affected by the cultural context and local learning cultures and how this should be considered in the design of m-learning technology.

In this paper, we present the results of a longitudinal study of culturally dependent issues in mobile learning service for mathematics. The aim of our study was to identify culturally sensitive areas in m-learning services. The results of our study will bring insight about culturally sensitive areas in mobile mathematics learning service which will help to localize similar m-learning services.

Our research focuses on a large scale and longitudinal study of learning mathematics by mobile phones. The Nokia Mobile Mathematics -project has been carried out in amongst secondary school teachers and pupils in urban and rural areas in South Africa. The project started in 2009 and is on-going reaching now already some 50 000 pupils and 700 teachers and is also aiming at other African countries such as Senegal and Tanzania. Recent research by Masita-Mwangi et al. (2012) has proposed m-learning with mobile phones as a viable and logical channel of delivering education for African youth.

Our main research question was: What cultural issues need to be considered in the design of mobile mathematics learning technology? The sub question in our longitudinal study was: What is the cultural context of mobile mathematics learning in South Africa? This paper brings insight into cross-cultural design practices for both academics and practitioners. For practitioners, our results describe knowledge of understanding practical cultural sensitive issues that have an impact on m-learning activities. For academia, the longitudinal results of cross-cultural research, resulting in both subjective and objective aspects categorized into the content, context, infrastructure and technology of mobile learning.

2. CROSS-CULTURAL DESIGN

Cross-cultural design is designing technology for different cultures, languages, and economic standings ensuring usability and user experience across cultural boundaries (e.g. Aykin, 2005). The demand and opportunity for cross-cultural design has rapidly arisen due to globalization: As companies are expanding their customer basis across national and cultural boundaries, cross-cultural issues have practically landed on designers' desktops and made them think about the cultural elements in design (e.g. Sun, 2012; Aykin, 2005). Whether it is about designing mobile phone applications, web-pages, tractors, cranes, lifts or washing machines, designers need to think about the end-users all around the world in different cultural contexts. Consequently, when designing for global and local users there are an unlimited number of ways to get it wrong (Chavan et al., 2009).

Culture is a complex concept and there is no simple explanation for it. According to Keesing and Strathern (1998) most anthropologists agree that culture is a learned behaviour consisting of thoughts, feelings and actions and is transferred in social interaction. Some anthropologists would like to limit the concept of culture to national and ethnic cultures, but most anthropologists seem to agree that social interaction is the most important prerequisite to produce and maintain a culture (Keesing & Strathern, 1998).

One way of looking at the concept of culture and bring it in to more practical level for a designer is to try model it somehow: of what it consists of and in what levels. Many researchers in the field of anthropology have studied objects, the patterns of behavior and thinking that differentiate one culture from another. For instance, Stewart and Bennett (1991) and Hofstede (2001) have compiled these into cultural meta-models.

Although technology researchers and practitioners have long been aware of the challenges of the global markets, there are still many unsolved problems concerning the extent to which culture may affect the product design and how to evaluate and analyze it (e.g. Smith et al., 2005; Schumacher, 2010). The influence of culture on user research has received much attention without much in the way of theory to support it (Snitker, 2010).

Two essential issues in cross-cultural design are identified as objective and subjective (e.g. Aykin, 2005; Smith et. al, 2005): There are objective issues, such as the language and format conventions of time of day, dates and number, and text directionality in writing systems. In addition, there are subjective issues such as value systems, rituals, behavioural and intellectual systems of one or more cultural groupings of users. All these aspects can affect the way how people in different cultures use and accept technology. These "deeper" levels of culture are often hard to study without user-centered research. In anthropology, an interpretive approach to the symbolic system of culture includes a long period of intimate study and participation in the everyday activities of the cultural members. Therefore, the analysis is context sensitive and interpretive and should focus on the “natives’ point of view” (Czarniawska-Joerges, 1992; Iivari, 2004; Keesing & Stratherm, 1998; Smircich, 1983). This suggests that longitudinal user-research could bring knowledge of those hard to examine culture sensitive issues for design.

Oyugi et al. (2008) categorized two areas in the design of technology that can be affected by culture: In relation to the actual product of development, cultural differences in signs, meanings, actions, conventions, norms or values raise challenging issues in the design of usable localized artifacts (Oyugi et. al, 2008). This means the actual artifact that is being created. In relation to the process of development, cultural differences potentially affect the manner in which users are able to participate in design and act as subjects in evaluation studies (Oyugi et. al, 2008). This means in practice that some user-centered research methods might work better in some cultures than in others and vice versa.

The user-centered design approach supports the cross-cultural product development process with user-centered activities (e.g. Aykin, 2005) identifying the need for internationalization and localization. Cross-cultural user research on-site or remotely will help to understand what and how has to be internationalized and localized.

3. MOBILE LEARNING AND SOUTH AFRICAN LEARNING CONTEXT

Learning with mobile devices is a global aim and phenomena, see e.g. UNESCO’s Education for All principle and Mobile Learning Technology Concept Development. Not only in the developed countries but also in the developing countries the spread of mobile technology has been rapid during the past ten years. According to Sharples et al. (2010), “new skills and literacies are enabled by mobile devices, such as SMS texting, moblogging (writing diaries and weblogs on mobile devices) and mobile video creation. A new generation of location-aware mobile phones will offer further possibilities, of education services and educational media matched to the pupil's context and interests”. Due to the fact that mobile learning has become a global phenomenon and existing design and evaluation principles are developed mainly for the users in western developed countries, these principles should be critically analyzed.

Several studies have been made about how to design, develop and evaluate mobile learning (e.g. Motiwalla, 2007; Sharples, 2009; Chu et al., 2010). However, only a few, if any studies focus on the longitudinal evaluation of the development process of a mobile learning system and the cultural context where mobile learning occurs. In relation to HCI research field, socio-cognitive engineering (SCE) (Sharples et al., 2002) and contextual design (CD) (Beyer and Holtzblatt, 1998) are studying human activities and how to support them with technology.

Socio-cognitive engineering (SCE) includes the analysis of activities that sets constrains how people use current technology and secondly, the design of new technology (Sharples et al., 2002). According to contextual design, ethnographic methods are used for gathering data in the field studies to understand the workflows to be able to design human-computer interaction (Beyer and Holtzblatt, 1998). However, these approaches focus mainly on tasks and activities. Little is known how e.g. values (Cockton, 2008) or attitudes towards individualism (Hofstede, 2001) affect on tasks that are performed and should be supported by technology. Furthermore, in mobile learning context, research is needed on how to recognize the issues that may vary in different countries among learners with the same age and the same level.

We argue that investigation of cultural issues is crucial for designers to be able to understand what is important and valuable for users, or in our case, for learners, for their parents and teachers and principals in addition to the educational system.

In the field of the research of education, the situations of learning can be classified into four different types: formal learning (pupils have little control over the objectives or means of learning), non-formal learning (pupils control the objectives but not the means of learning); informal learning (pupils control the means but not the objectives of learning) and self-directed learning (pupils control both the objectives and means of learning) (Mocker and Spear, 1982). Learning with mobile devices could happen in anywhere at any time (Kukulska-Hulme et al., 2011). Also, the learning material that mobile devices provide could contain additional information or exercises, designed according to the specific curriculum. When exploring learning mathematics with mobile devices in South Africa, we focused on particularly on informal and formal learning. The learning material was developed according to the existing curricula in collaboration with South-African school personnel and service developers.

Table 1. Key figures in South Africa learning context

	South Africa
Inhabitants	Approx. 50 million
Student-to-teacher ratio (primary educ.)	30.71 to 1
Student-to-teacher ratio (secondary educ.)	30 to 1
Literacy rate (%)	88.72
Total enrolment/primary education (%)	89.43% (male), 90.66% (female)
Public vs. private schools	24693 public schools (12 million learners) and 1174 private schools (386098 learners).

To understand the learning culture in South-Africa, we need to know the educational system. In 2009, there were 24693 public schools in South Africa (12 million pupils) and 1174 private schools (386098 pupils) (ICT for Teaching and Learning in South Africa, 2011). In addition, the student-to-teacher ratio in South Africa is high (see Table 1).

According to ICT for Teaching and Learning in South Africa (2011) student-to-teacher-ratio in private schools (primary, secondary, middle and combined) is 16 to 1. According to the 2003 Trends in Mathematics and Science Study (TIMMS, 2003), there is a challenge in mathematics teaching in South Africa. The international average maths score in 2003 was 467 whereas in South Africa it was 264. In addition, there is discrepancy in mathematics achievement across provincial, gender, economic and racial divides (TIMMS, 2003). For example, between 1999 and 2004, an average 4.4% of the matriculants achieved "mathematics passed adequate for entry into natural sciences at university level". In 2006, only 4.8% passed higher grade 9 maths, (Fin24, 2008) and the prognosis for the matric classes of 2010 and 2011 was not much better.

To solve the challenges, several initiatives have established, focusing on training teachers to meet current and future requirements and ensuring that adequate measures for pupils to move from secondary education into higher education (HE) institutions or the labour market (JIPSA, 2008). However, the role of technology is not specified at all, thus leaving the field open for research into the possibilities offered by technology.

Table 2. Key figures in Phase I and Phase II

	Phase I	Phase II
Schools	6	30
Participants	241 (232 pupils, 9 teachers)	3975 pupils
Delivery channels	SMS and MXit	MXit and DLA
Duration	From 7 to15 weeks	From 8 to 15 weeks

4. METHODOLOGY

In our research, we utilized a case study method based on data gathered by our industrial partner Nokia during 2008, 2009 and 2010. This longitudinal study was part of Nokia Mobile Mathematics -project conducted in South Africa for grades 9 and 10. The learning content includes tutoring, theory, peer-to-peer support, competitions, tests, self-assessment, and thousands of exercises. Teachers could use the exercise bank and theory for in-class teaching, follow-up, analyzing and monitoring how the pupils are doing with their exercises. Teachers could also collaborate with pupils e.g. by sending them reminders about homework or encouragement. The mobile learning service is currently used in 200 schools in South Africa.

The longitudinal study was conducted in two phases during the years 2009 and 2010 (pilot tests were conducted in 2008). Phase I started in February 2009 and ended in September 2009. Phase II started in October 2009 and ended in December 2010. Several quantitative and qualitative methods were used for gathering the data: 1) log files of the actual usage of the mobile learning systems, 2) questionnaires investigating teachers' and principals' attitudes and current ICT skills and ICT usage before and after using mobile math learning service, 3) focus group interviews with teachers and pupils, 4) observation of lessons, and 5) thematic interviews with principals, teachers and pupils.

During the Phase I in 2009, attitudes towards collaboration in learning were examined with a questionnaire (a six-point Likert scale from 1 = "Very strongly agree" to 6 = "Very strongly disagree") with 9 teachers and 232 pupils. In 2009, pupils' attitudes to mathematics and perceptions of value of technology use were measured in February and in April. The general attitude towards mathematics was measured using A Mathematics-Related Beliefs Questionnaire (MRBQ) (Op ´t Eynde, P. & De Corte, 2003). The data was analyzed with descriptive statistics and content analysis where appropriate.

In the Phase I in 2009 there were altogether six schools with pupils from grades 9 or 10 mathematics class in each school. During the Phase I, five of the selected schools, with 232 pupils in total, used browser-based learning service (MXit) during 15 weeks. One school with grade 9, a class with 37 pupils, used SMS-based applications during seven weeks. There were altogether nine teachers in our study in Phase I. The data was gathered twice: at the beginning of Phase I (during February and March) and at the end of the Phase I (in April). The selection of schools was made by Nokia and the project team.

In Phase II, the study was conducted in two cycles: during October 2009, January 2010 and June 2010 and during July 2010 and December 2010. The Phase II focused on Grade 10 Mathematics with two technologies: 1) browser-based learning service (MXit) or as it was called social networking application (SNA) and 2) dedicated learning application (DLA). Altogether there were 30 schools in the Phase II. 25 schools used SNA and five schools used DLA. During the Phase II, there were altogether 3957 pupils who had registered themselves into learning services, but 62 % of them were active pupils (n=2471). Pupils were considered 'active' if they had completed a practice exercise or test using the platform.

With these quantitative and qualitative research methods, we obtained both objective and subjective data about the actual use of the mobile learning service and attitudes towards mobile learning. To understand what cultural issues need to be considered in the design of mobile mathematics learning technology, two of the researchers categorized the results in objective and subjective issues (E.g. Aykin, 2005; Ouygi et al., 2008).

5. RESULTS

Objective and subjective culturally sensitive aspects related to mobile learning were identified from the context.

5.1 Objective Issues

The first objective issue is the level of mobile network coverage, which is a fundamental requirement for mobile learning services. South Africa has the most advanced telecommunications network in Africa. This was a good starting point for developing mobile mathematics learning service in South Africa.

The second issue was the level of mobile penetration: in 2009, South Africa had 46.4 million mobile telephones in use, as well as 4.4 million internet users (ICT for Teaching and Learning in South Africa, 2011).

The third issue was the language used at school and pupil's level of that language. South Africa has about 50 million people of diverse origins, cultures, languages, and religions and eleven official languages are recognized in the constitution. Two of these languages are of European origin: English and Afrikaans. Although English is commonly used in public and commercial life, it is only the fifth most spoken home language. The education sector does not totally reflect the multilingual nature of South Africa. English is often used as the medium of instruction at the expense of Afrikaans and African languages (ICT Development Associated Ltd., 2011).

Fourthly, the content of the mobile mathematics material was aligned with the South African curriculum and level of maths. In a context where math results tend to decline substantially from Grade 9 to Grade 10 in South African Public Schools, the pupils who used the Nokia Mobile Mathematics service regularly (completing more than 15 practice exercises and tests) achieved results for Grade 10 were 7% better on average than their peers.

The fifth issue found is society's school system: e.g. are there public or private schools in the target area? What is the student-to-teacher ratio?

The sixth issue is how schools and education systems allow the use of mobile technology during school hours. In our study, 81% of the case study schools have an ICT policy or school code of conduct that restricts the use of mobile telephones during school time.

The seventh important issue was to understand how much pupils and teachers used the service. In 2009, 85% of the pupils had mobile phones with SMS capacities and 64% of them were able to use the browser based learning system with their mobile phones. The average posts per week for those pupils who used browser-based service was 3.99 posts per week and for SMS –based service users 1.69 per week. In 2010, there were altogether 2875 registered users and 1528 of them were active users. Of these pupils, 75% reported that they had their own mobile phones and 67% reported that their mobile phone could download browser-based service. In addition, 17% reported that they could access a shared mobile telephone, which could download browser-based service, at home. However, 13% of case study pupils were unable to use either their own or a shared mobile phone. Total views and post were 46989. At the beginning of Phase II in 2010, two technologies were in use i.e. SNA and DLA.

During the second cycle of Phase II, all the users were using the same SNA technology. Over one year, more or less than 102000 attempts were made on practice tests and examinations. In 2009, there were more than 53 logs per week for those teachers, who used the browser-based service. Only one teacher was using SMS-based learning service and had more than 39 logs per week. In 2010, there were 72 teachers who registered on the browser-based SNA system, which comprised Moodle for computer-based access and MXit for mobile access. As with the pupil numbers, there were fewer teachers who actually used the system, than those who registered on it. During the nine week period 48 teachers (66% of those registered) used the learning system (view and post). One teacher never used the system. Teachers who used the system could be categorized into rare users (less than ten view and posts per class), occasionally users (between 10 and 50 views and posts per class), frequent users (between 50 and 200 views and posts per class) and extensive users (more than 200 views and posts per class). The schools having teachers who were identified as frequent or extensive users were in three schools which had participated in the phase one intervention, i.e. these teachers were in their second year of making use of the platform.

In the other technology used in 2010, DLA, the 'total sent messages' reflected how many messages had been sent by the teacher to individuals using the system. These messages were mostly likely sent to a group (their class of pupils). The teachers in the DLA schools did not seem to use the system very much at all. In one school it was never used, in three schools it was very rarely used. The only real use by a teacher was evident in one school, where the teacher used the system to send six different messages, which meant a total number of 141 messages to their pupils.

5.2 Subjective Issues

Pupils' attitude towards mathematics is a subjective issue affecting the use of mobile learning technology. In the February 2009 measurement, most of the pupils seemed to be very confident about their skills in mathematics (weighted average pupil response 1.58 and SD 0.92). The second measurement was made in April and indicates a shift from the previous statements. The pupils still agreed with the statements, but less strongly. A notable shift was regarding the statement "I can usually do mathematics problems that take a long time to respond" towards greater agreement.

In relation to pupils' expectations, it seems that those, who used browser-based learning service, agreed strongly in February 2009 that they expect really enjoying using the mobile phone to help with mathematics. In April, they tend to agree less with these statements using "agreed" instead of "strongly agree". The pupils' attitude to mathematics seemed to improve as learning mathematics was seen enjoyable or fun. In April, pupils were strongly agreeing (weighted average 1.31 and SD 1.01) that "I think I will really enjoy/I enjoyed using my cell phone to help mathematics".

Pupils' attitude towards collaboration was another subjective issue related to the use of the service. Regarding the collaboration between pupils, in 2009 pupils' attitudes indicate that there was a great agreement with the statement "discussing different services to a mathematics problem is a good way of learning mathematics" and the agreement was even greater in April, when the attitudes were measured the second time. However, in 2009 the pupils also indicate that they are not primarily motivated to compare themselves with other students. In 2010, the maths chat facilities in the SNA for mathematics were developed late into the nine-week period. The type of activity use was analyzed from the views and posts for SNA pupils, over the nine-week period. This showed that most activity related to answering practice tests, viewing theory and answering tests. There was minimal use of the messaging and results facilities. The regular users most commonly indicated as some of the best features of the service social aspects such as the discussion wall, messaging and bulletin boards.

Teachers' attitudes towards mathematics were also a subjective issue affecting the use of mobile learning technology. In 2009, nine teachers' views about the impact on their pupils' attitudes to mathematics were asked with a four-point Likert-scale from "strongly agree" to "strongly disagree". In February, of the teachers, 33 % strongly agreed and 67% agreed that the project "will significantly improve pupils' attitude towards mathematics". In April, 50 % strongly agreed and 50 % agreed with that same statement. In addition, teachers' expectations and reflections on pupils' competence in mathematics were explored with a four-point scale. In February, 33% of the teachers strongly agreed and 50% agreed that project "will significantly improve my pupils' mathematics results". Of the teachers, 17% choose "no comment" as their answer. In April, 17% of the teachers strongly agreed and 83% agreed with the same statement.

Teachers' attitudes towards collaboration: Better communication possibilities at any given time seem to be one of the main strengths in the mobile math learning system according to teachers. Some teachers valued that they could communicate more with their pupils, especially outside of school working hours even during holidays and after school. However, only few teachers thought that the potential for collaboration amongst pupils is strength in using this particular learning system. Of those who see some collaboration possibilities argued that pupils could learn from each other, collaboration could lead to maths discussions and therefore for improved results and peer assessment as they will be able to chat with each other.

Table 3. Proposed design questions to help the design of mobile learning services for school context.

What language is used at school? What language is used at home?
What is the pupils' level of that language used at school? Does it have implications to design e.g. does more simple language need to be used in the content?
Does the content need adaptation to the local curricula and level of maths?
What would be the best target age for the learning service?
How to implement mobile service to the existing school system?
Who is responsible for taking the system into use, maintaining it and plan the use to be part of the school day?
What kinds of instructions are needed?

Teachers' concerns: Teachers were asked about the inappropriate use of the mobile learning system and they reported that some pupils might become "addictive on chatting" and "unbalanced". In addition, some teachers were concerned about pupils' and their parents' motivations, pointing out that it is important to convince the parents that mobile learning system can be used for good. In addition, teachers think that some parents may not allow their pupils to use the mobile learning system and may even accuse teachers of influencing their children negatively. This indicates that the parents should be informed carefully when adopting new technology to support learning at school.

6. DISCUSSION

In this study, we examined some cultural issues affecting the mobile mathematics learning service. From the designer's point of view some of the culturally sensitive issues are easy to identify. They are objective issues such as a language and writing system of the service, mobile phone penetration and network coverage, the local school system affecting how to implement mobile service into the existing school system and how to adapt it to match the local curricula of maths. The level of maths in the targeted age group was important to know for designing the content as well as teachers' level of ICT literacy. Based on the results, we present in Table 3 a number of design questions related to objective cultural issues. We suggest that designers consider these questions before designing mobile learning systems in school context.

In South African environment it was found that it is important to encourage the informal use of the service as the churn rate of teachers at school is high and the information disappears when a teacher leaves the school. This finding encouraged the development of the service towards a more informal way of using it: independently and outside school hours. Because of the low teacher-to-pupil ratio in public schools, mobile learning service could help teachers to keep up with the pupils' learning progress as well as give teachers more ways to communicate with the pupils than in a traditional set up.

As mentioned earlier, in the study of culture in anthropology, a longer period of study is encouraged to find out the "natives point of view" (Czarniawska-Joerges, 1992; Iivari, 2004; Keesing & Stratherm, 1998; Smircich, 1983). We suggest that mobile learning and its effect needs to be evaluated during longer periods of time because taking new learning technology into use takes time. With longer user studies attitudes towards new technology can be recognized and measured and results of how technology is being used can be studied. Also, the learning results can then be measured. We want to emphasize in the context of mobile learning that researchers should pay more attention to the organizational culture, i.e. school norms and values, when adopting new technologies. In our case, nearly every school had written regulations that forbid pupils using mobile phone during the school days. This inevitably has an effect on the attitudes on using mobile devices for learning during school days.

There are some limitations in our study. Previous studies have shown (Chu et al., 2010; Motiwalla, 2007) that regarding the relationship between learning outcomes and usability of the system, the cognitive load of using the system is an important factor. Therefore, in the future standardized measurement tools for examining both pupils and teachers' cognitive load should be conducted.

7. CONCLUSION AND FUTURE WORK

In this paper, we aimed to present the results of a research on the effect of cultural context on user experience of mobile mathematics service. The aim of our study was to identify culturally sensitive areas in the local context of mobile learning services in order to give insight for localization of these services. Our research focused on a large scale and longitudinal study of learning mathematics by mobile phones amongst secondary school teachers and pupils in South Africa. Our main research questions in this paper were: what cultural issues need to be considered in the design of mobile mathematics learning technology? We argue that both objective and subjective aspects according to existing cultural models should be analyzed. We also present design questions that can help in the design of mobile learning services for school context (see Table 3).

In the research of learning in different cultures in mobile learning context it is important to study the service use over the longer period of time to see the results of learning, to find out how the new way of learning is taken into use and how it is accepted by teachers and pupils. Also, longitudinal study is required in order to see a possible change in attitudes towards new technology. The research of cross-cultural issues in these areas support service developers to understand the local contexts, which is a vital issue when the main aim is to integrate mobile learning into the everyday processes of an ordinary school day in different countries with a different cultural background.

More research is needed in the area of collaborative and informal m-learning in different cultures. Therefore, we will continue to study the localization requirements for mobile mathematics service, looking into topics such as a) Concept (e.g. motivation, attitudes towards maths, formal/informal learning), b) Content (e.g. the support of the software for the writing systems), c) Technology (e.g. what kind of support is offered for the service in the country), and d) Infrastructure (e.g. level of maths, the school system).

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MOBILE LEARNING AND ACHIEVEMENT GOAL ORIENTATION PROFILES

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ABSTRACT

Students with different achievement goal orientations have different approaches towards learning and studying. There is a widespread interest to find an easy access into learning spaces for those students who have low motivation with fear of failure and academic withdrawal. Mobile learning offers an easily accessible chance with low threshold to view materials and to carry out mobile assignments. The topic of this cases study was to investigate different achievement goal orientation profiles combined with mobile learning. The aim of the study was to reveal if any correlation could be found between students' achievement goal orientation profiles and results from mobile assignments students did with smartphones on the course "The basics of databases". The sample consisted of students in the second academic year (N=173) at the Faculty of Technology at Lahti University of Applied Sciences in Finland, of whom 64.7% had an achievement goal orientation profile (n=112). The results of the study imply that no difference can be found between orientation profiles and outcome from mobile assignments. Contrary to what was expected, students with a positive orientation profile (mastery-oriented and success-oriented) did not get any better results from mobile assignments than students with a negative orientation profile (avoidance-oriented). This in turn implies that students with an avoidance-oriented profile could benefit from mobile assignments.

KEYWORDS

Mobile assignment, m-questionnaire, achievement goal orientation profile, motivation

1. INTRODUCTION

Lahti University of Applied Sciences (LUAS) is a multidisciplinary higher education institution. The Faculty of Technology operates in the field of technology and engineering. Teachers in the Department of Information Technology have noticed that the number of students who lack studying motivation has increased. It can be seen in a variety of ways. For example, students do not come into examinations, do not come to school, do not hand in essays in time, do not value the engineering program, and sometimes in classroom situations the teacher's authority is at a very low level (Veijalainen et al., 2013).

At the end of 2008 there were 6.9 million mobile phone subscriptions in Finland (OSF, 2009). As the latest population figure in Finland is about 5.4 million (OSF, 2013) it is presumable that every student has a mobile phone at hand. Mobile phones provide a learning environment which is omnipresent and free from time and space limitations. For those students who might have low studying motivation and who struggle with their studies, a mobile phone could be one tool to keep up.

The aim of this research was to study whether there is any kind of correlation between students' orientation profiles and results obtained from mobile assignments. It is also interesting to see if any correlation can be found between the results of mobile assignments and other background variables.

2. BACKGROUND

2.1 Achievement Goal Orientation and Additional Motivational Indices

Achievement goal orientations, in other words orientations related to learning and performance, reflect on how students orientate themselves towards learning and studying, what kind of goals they endeavor, and what kind of final results they aim at (Tuominen-Soini et al., 2010). Goal orientations refer to a disposition that manifests itself in the individual's propensity to select certain goals and to favor certain outcomes; it reflects individuals' preferences for particular types of desired end-states (Niemivirta, 2002b; Tuominen-Soini et. al., 2008). Goal orientations are also connected to supportive and maintaining, as well as disturbing and preventive, impressions and beliefs of learning (Niemivirta, 2002a).

As Tuominen-Soini et al. (2010; 2012) write, traditionally there has been a division into two separate orientations in a learning situation: mastery orientation, in which students tend to emphasize learning and mastering knowledge, and performance orientation, in which students are driven by achievements. Tuominen-Soini et al. (2008; 2012) continue that all students do not actively try to learn, but actually try to survive studies with a minimum workload. This passive approach is called avoidance orientation.

Elliot and Harackiewicz (1996) divided the performance orientation into performance-approach orientation and performance-avoidance orientation. *Performance-approach orientation* is directed at demonstrating competence (Elliot & Harackiewicz, 1996; Tuominen-Soini et al., 2011, 2012). It reflects a student's endeavor to succeed in respect to other students and to show competence (Tuominen-Soini et al., 2010). Performance-approach goals may have a positive effect on effort, persistence, and graded performance or achievement, but the pursuit of such goals may also be associated with anxiety, superficial processing and stress (Tuominen-Soini et al., 2008). Performance-approach orientation is a significant predictor of academic achievement. *Performance-avoidance orientation* in turn is directed at avoiding the demonstration of normative incompetence and public image of ineptness (Elliot & Harackiewicz, 1996; Elliot & Church, 1997; Tuominen-Soini et al., 2010, 2011, 2012). Performance-avoidance goals have been found to be linked with negative outcomes and indices of maladaptive adjustment, such as anxiety, hopelessness, superficial and disorganized study strategies, lower performance, self-concept and self-efficacy, and self-handicapping (Tuominen-Soini et al., 2008, 2010).

Mastery orientation has also been divided into two more specific orientations: mastery-extrinsic orientation and mastery-intrinsic orientation. Tuominen-Soini et al. (2012) write that students with *mastery-extrinsic orientation* have a tendency of relying on external criteria as source of motivation. They continue that these students seek to master school subjects and focus on absolute success. Students with mastery-extrinsic orientation tend to use external criteria such as grades or explicit feedback for evaluating whether one has attained the given goal of mastering a subject or learning a new thing (Tuominen-Soini et al., 2011). They add that these students focus on absolute success instead of relative success. According to Tuominen-Soini et al. (2010), mastery-extrinsic orientation is related to positive factors like experiencing the significance of school or good success in school, but it can also be related to negative factors like stress and emotional exhaustion. In their article Tuominen-Soini et al. (2008) state that mastery-extrinsic orientated students not only relate to mastery focused tendencies (e.g., active coping and effort expenditure) but also to performance-related concerns (e.g. fear of failure and excessive worrying). *Mastery-intrinsic orientation* has been less studied. Students with this orientation use intrinsic criteria (e.g. the phenomenological feeling of knowing and understanding) for evaluating whether they have achieved mastery or not (Tuominen-Soini et al., 2008).

The objective of students with *avoidance orientation* is effort reduction by avoiding challenging tasks, putting forth as little effort as possible and trying to get away with it (Tuominen-Soini et al., 2011; Tapola & Niemivirta, 2008). Tuominen-Soini et al. (2008, 2010) write that avoidance goals have been found to be associated with lower performance, interest and enjoyment, low or superficial use of strategy, alienation and cynical attitudes toward school, negative affects, and external attributional patterns.

The theory of achievement goal orientations suggests that the students with different achievement goal orientations differ from each other also in other motivational indices. The motivational indices which are linked with achievement goal orientations and used in this study are planning, executive approach, innovating approach, academic withdrawal, fear of failure, and studying. *Planning* in this context describes students' endeavor to plan different phases or issues related to studies beforehand (Niemivirta, 2002a). Executive and innovating approaches are orientations of thinking and problem-solving. *Executive approach* is a way to solve problems where guidance and structure are important. A student with executive approach wants to follow instructions and work using ready-made templates (Niemivirta, 2002a). A student with *innovating approach* solves problems using innovative thinking and new ideas. He/she is driven by a desire to create and apply new and different solutions to problems (Niemivirta, 2002a). *Academic withdrawal* is a tendency to give up or get paralyzed when facing challenging learning or performance situations (Niemivirta, 2002a, 2002b; Tapola & Niemivirta, 2008). *Fear of failure* in turn reflects the fear and anxiety to fail in studies

(Niemivirta, 2002a, 2002b; Tapola & Niemivirta, 2008). *Studying* implies what the student's impression is about the support he/she is getting from teachers and how well individuality has been taken into account in studies.

By classifying students according to their achievement goal orientations and additional motivational indices, it is possible to identify existing achievement goal orientation profiles. That gives a good starting point for finding those students who hover between giving up and continuing their studies, and for innovating new learning environments which could be of help, even small, to them.

2.2 Mobile Learning

Learning and teaching by using technology are wide areas to study. Distant learning crystallizes all those doctrines and directives where the teacher and student are physically apart from each other in place and time. Electronic learning is conducted by using computers, but it does not bring real freedom of choice. Mobile learning (m-learning) is carried out by using small, hand-held devices. These can be for example PDAs or mobile phones. So, mobile learning is not simply a variant of e-learning enacted with portable devices, nor an extension of classroom learning into less formal settings (Vavoula et al., 2009). As Pachler et al. (2010) state, m-learning is not about delivering content to mobile devices but, instead, about the processes of getting familiar with and being able to operate successfully in, and across, new and ever changing contexts and learning spaces. It is about understanding and knowing how to utilize our everyday-life worlds as learning spaces (ibid.).

By its very nature, anytime, anyplace learning assumes that the learners start with a need and a motivation for some information that will help them perform an immediate action (Metcalf, 2006). Learners should be able to engage in educational activities without the constraints of having to do so in a tightly delimited physical location (Kukulska-Hulme & Traxler, 2005). To a certain extent, learning outside a classroom or in various locations requires nothing more than the motivation to do so (ibid.).

3. METHOD

3.1 Participants and Context of the Study

All the participants were second grade engineering students from the Faculty of Technology or second grade ICT students from the Faculty of Business Studies in LUAS attending a compulsory course called "The basics of databases". In this research, two different course implementations were studied; autumns 2011 and 2012. The course included database planning with the entity-relationship model, relational design, normalization, transaction theory and database language SQL. The course was held in the beginning of the second academic year, and gives 3 credits. In order to get the credits, students needed to pass both the course examination and complete 3 out of 6 sets of mobile assignments (m-questionnaires). There was no grade limit in the mobile assignments. The results from mobile questionnaires made up 20% of the final course grade.

The motivation questionnaire instrument by Niemivirta (2002b) was used for assessing both achievement goal orientations and additional motivational indices. The questionnaire included items for both of them. For example, the question item for mastery-intrinsic orientation was "To acquire new knowledge is an important goal for me in school", the question item for mastery-extrinsic orientation was "My goal is to succeed in school" and the question item for avoidance orientation was "I try to avoid situations in which I might fail or make a mistake". Students rated all items using a 7-point Likert-type scale ranging from 1 (not true at all) to 7 (very true). In the autumn of 2011 the achievement goal orientation questionnaire was in paper form and in the autumn of 2012 the questionnaire was in the form of Google Docs Form. Answers were saved into IBM SPSS Statistics 20 software and into Mplus statistical modeling program.

In autumn 2011, 92 students, both full-time day students and mature students, participated in the course. It was possible to combine 63.0 % of these students (n=58) to the results from achievement goal orientation profiles study, as 30 students did not give their student number in the achievement goal orientation questionnaire. Four students dropped out of the course. In autumn 2012, 86 full-time day students participated in the course. 47.7 % of these students answered the achievements goal orientation questionnaire (n=41). One student did not finish the course. The total number of students on these two course implementations were 173, of whom 99 (57.2 %) had an achievement goal orientation profile.

On the course the lecturer sent Google Docs Form links into mobile phones of those students who had one, and who were willing to pay for the telecommunications operators' bill themselves. Those students who had no smartphone or did not want to use their own phone, for some reason, were given an opportunity to use smartphones (Nokia N900) in the classroom during course lecturing.

Students were sent six different m-questionnaires, which were related to subjects discussed in the classroom. The maximum number of points, which was the total from all the m-questionnaires, was 30. Thus one m-questionnaire could give a maximum score of 5 points. In each m-questionnaire there were five different items to answer. The items were of check-box or radio-button type. Check-box items could have multiple choices to click - or none - for the right answer, whereas with radio-button there was only one choice. A wrong choice could give minus-points, though the minimum points from one item was zero. A new m-questionnaire was given every week. Originally the idea was to give only one week to answer every set of m-questionnaires, but students requested more time, so they were given several weeks to answer the m-questionnaires. The right answers were given before the course examination.

3.2 Measures and Data Analyses

The latent class analysis (LCA) was used for classifying students according to their responses to different achievement goal orientations. This analysis was performed using the Mplus statistical modeling program, version 7.11 (Muthén & Muthén, 1998-2012). Mplus offers Bayesian Information Criterion (BIC), Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR) and Lo-Mendell-Rubin adjusted LTR -test (LMR) in order to conclude which number of classes is the best choice (Lo et al., 2001). The lower the BIC value is, the better the model fits to the data. Low VLMR and LMR p-values indicate that the model with one class less is rejected in favor of the estimated model (Muthén & Muthén, 1998-2012).

The data from background variables were saved into IBM SPSS Statistics 20 file for statistical analysis about the students attending "The Basics of Databases": (1) *Achievement goal orientation profile* – the information about the student's achievement goal orientation profile (mastery-oriented, success-oriented, indifferent, avoidance-oriented, no profile); (2) *Gender* - whether the student was a man or a woman; (3) *Mature or full-time* - if she/he was a mature student or full-time day student; (4) *Degree programme* – student's degree programme, whether it was IT (Information Technology), MT (Media Technology) or ICT (Business Information Technology at the Faculty of Business Studies); (5) *Whose mobile phone* - if the mobile phone used was the student's own or owned by the Faculty of Technology; (7) *Number of answered m-questionnaires;* (8) *Grade from m-questionnaires* - the grade which the student got from mobile questionnaires and (9) *Grade from course examination.*

4. RESULTS

4.1 Achievement Goal Orientation Profiles

One goal of this study was to examine what kinds of achievement goal orientation profiles can be identified among students. Different numbers of classes were tested with LCA, and the information criteria values showed the four-class solution to fit the data best.

After finding the best fitting model, these four classes were given labels. Group labels were decided according to the score mean profiles as (1) *mastery-oriented*, (2) *success-oriented*, (3) *indifferent* and (4) *avoidance-oriented*. The students in the mastery-oriented group (n=24, 24.2%) have high scores in mastery-intrinsic orientation, but quite low scores on all other orientations. An important goal for them in school was to learn and understand as much as possible (Tuominen-Soini et. al, 2012, 2011, 2010, 2008). Success-oriented (n=51, 51.5%) students expressed high levels of both mastery orientations and performance-approach orientation. They seemingly strived for both absolute and relative success, although they considered the goal of learning and understanding important as well (Tuominen-Soini et. al, 2012, 2011, 2010, 2008). The students in the indifferent group (n=6, 6.1%) represented a typical student in the sample with their joint - yet weak - emphasis on mastery, performance, and avoidance. In other words, they did not display a dominant tendency towards any specific achievement goal orientation (Tuominen-Soini et. al, 2012, 2011, 2010, 2008). Indifferent students had scores close to the sample mean on all achievement goal orientations (Tuominen-Soini et. al, 2012). Avoidance-oriented students (n=18, 18.2%) scored high on avoidance orientation and, in contrast, very low on mastery-intrinsic and mastery-extrinsic orientations. They mainly aimed at minimizing the effort and time spent on studying (Tuominen-Soini et al., 2012, 2011, 2010, 2008). (Tuominen-Soini et al., 2012, 2011, 2010, 2008, 2004; Niemivirta, 2002a, 2002b; Tapola & Niemivirta, 2008)

4.2 Correlations

A Pearson Product Moment Correlation (Holopainen & Pulkkinen, 2002; Metsämuuronen, 2002, 2006) was run to measure correlation between achievement goal orientation profiles and background variables (Table 1). There was statistically significant correlation ($p < 0.01$) between both gender and full-time day student/mature student with degree programme. The correlation between degree programmes and mature/full-time day students is biased, as there are mature students only in the information technology degree programme, and not in the media technology or ICT degree programmes. The correlation between degree programmes and gender is also biased. There are only 10.2% women in information technology degree programme, 13.3% in ICT degree programme and 33.3% in media technology programme. A total of 83.8% of students (n=145) in this study were men, and 16.2% were women (n=28). The percentage of full-time day students was 93.6% (n= 162), and 6.4% were mature (n=11) students. There was also a significant positive correlation between the number of answered m-questionnaires and the grade got from m-questionnaires. This is self-evident, as the more you answered m-questionnaires, the more you would get points from them.

Far more interesting were the correlations between orientation profile and grades from m-questionnaires (Table 1, Figure 1), and the correlations between gender and grades from m-questionnaires (Table 1). The positive significant correlation between grades from m-questionnaires and orientation profiles suggests that success-oriented students tended to get grades 2, 3 and 4 from m-questionnaire assignments, which somehow supports the theory of orientation profiles. Another noticeable observation in Figure 1 is that avoidance-oriented students have got grades 4 and 5 from m-questionnaires, as according to the theory of orientation profiles these grades should be in the other end of the grading scale. The correlation between grades from m-questionnaires and gender was statistically nearly significant ($p < 0.05$). Women seemed to get a little bit better grades than men.

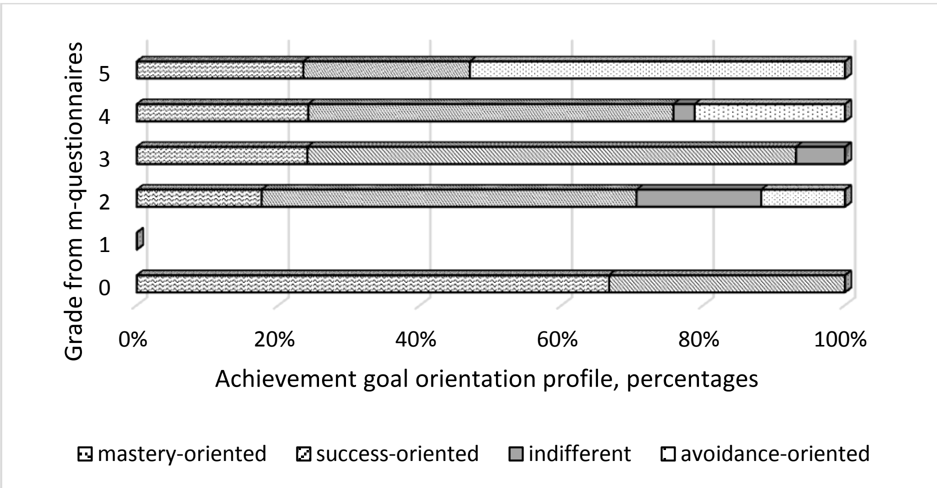

Figure 1. Graph about correlations between grade from m-questionnaires and achievement orientation profile.

Other interesting correlations were between the grade from the course examination and the achievement orientation profile (Table1), and between the number of answered m-questionnaires and the grade from m-questionnaires (Table 1). The correlation was at a statistically nearly significant level between the grade from the course examination and the orientation profile, showing a possible relation. The unexpected result is that students with the avoidance-oriented profile had got as good grades from the course examination as students in mastery- and success-oriented profiles. There were no fails among them, and not even grade 1, which could have been the expected result.

The correlation was statistically significant between the grade from the course examination and both the number of answered m-questionnaires and the grade from m-questionnaires (Figure2, Table 1). This implies that the effort made with m-questionnaires helps the student to pass and succeed in the course examination. Only 13 (9.6%) of those students who answered all 6 m-questionnaires (n=135) failed the course examination.

Table 1. Correlations between achievement orientation goal profiles and background variables

Variable	Achievement goal orientation profile	Gender	Mature or Full-time day student	Degree programme	Whose mobile phone	Nbr of answered m-questionnaires	Grade from m-questionnaires
Gender	-.19	-					
Mature or Full-time day student	-.16	.14	-				
Degree programme	.11	-.21**	.20**	-			
Whose mobile phone	-.11	-.01	.04	.05	-		
Nbr of answered m-questionnaires	.17	.12	-.07	-.11	.03	-	
Grade from m-questionnaires	.26**	.16*	.07	-.04	.13	.72**	-
Grade from course exam	.25*	.02	.03	.14	-.06	.24**	.37**

Note. *p < .05, **p < .01

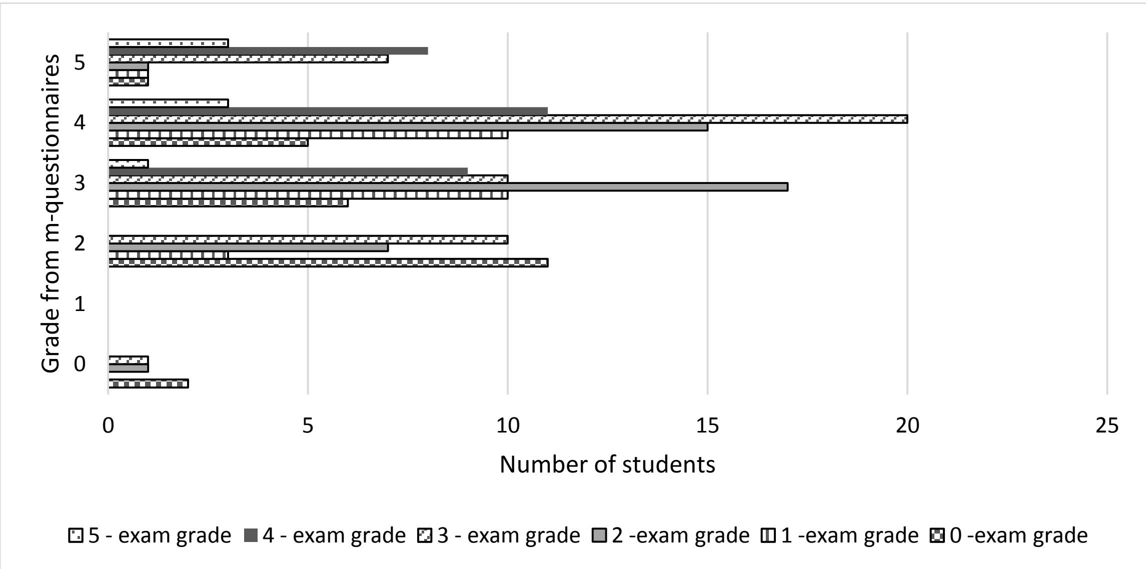

Figure 2. Graph about correlations between grade from course examination and grade from m-questionnaires.

5. CONCLUSION

In order to be able to help students who struggle with their motivation to study, those students need to be recognized first. The instrument developed by professor Niemivirta allows the researcher (lecturer) to identify different achievement goal orientation profiles among students, and hereby introduce pedagogical actions if needed. One possibility to encourage the students with low or negative motivation is to use learning spaces which differ from traditional learning environments. As the result of this research implies, students with an avoidance-oriented profile seem to benefit from mobile assignments. There was no correlation between avoidance-oriented students and the number of answered m-questionnaires, which means that they were just as eager to do mobile assignments as students in the mastery- and success-oriented profiles. As there was a statistically significant positive correlation between the number of answered m-questionnaires and the grade from the course examination, the profit from m-questionnaires seems to be even more valuable.

The results from the achievement goal orientation profiles must be interpreted with caution. As the basis of the profiles is a questionnaire, one must keep in mind that there is always room for error, when a student fills out the questionnaire. Has she/he understood the questions correctly, i.e. which end to choose from the Likert scale so that the answer is as close as possible to her/his opinion? Or what is the state of mind at the moment when the answers are ticked; should she/he choose 4, 5 or 6 from the Likert scale? However, whatever the orientation profile, according to the correlations of this research, mobile assignments seemed to be a suitable learning tool for everyone. The second aspect which must be considered with some reservations is the use of smartphones in the classroom situation. 75.7% of students used their own smartphone. Still, a quarter of the students used a smartphone the Faculty offered. It is not known if they did not have a smartphone or if they did not want to give their private phone number to the lecturer. Those 42 students who used Nokia N900 smartphones in the classroom were in a worse position than the others. They had no peace to do and think thoroughly about the mobile assignments as there was only a short time during the lessons for them. It was not possible to give Nokia N900 smartphones home, because their number was limited and they were needed constantly at the Faculty. If mobile learning environments become a constant tool for teaching, it must be ensured that every student has equal opportunity to do them. The third aspect to take notice of is that in this research no proper mobile learning environment tool or application was used, only Google Docs Form through web browser. The experience from mobile assignments might be totally different if a real mobile application were used.

In spite of its limitations this research suggests that mobile assignments could offer a useful tool to encourage students to study, especially those with motivational challenges.

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A REVIEW OF INTEGRATING MOBILE PHONES FOR LANGUAGE LEARNING

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ABSTRACT

Mobile learning (m-learning) is gradually being introduced in language classrooms. All forms of mobile technology represent portability with smarter features. Studies have proven the concomitant role of technology beneficial for language learning. Various features in the technology have been exploited and researched for acquiring and learning languages. This paper presents a review of empirical studies on the integration of mobile phones in language learning contexts published from 2004 to 2013, a total of ten years. Studies on m-learning for languages were located and retrieved using Google Scholar and library databases. Thirty-three (33) studies were analysed using Nvivo software. The main findings include: (a) Japan as the country which contributed the most studies employing mobile phones; (b) tertiary learners are the most prolific participants of studies; (c) vocabulary is the most popular language area learnt on mobile phones; and (d) quantitative is the most popular research design chosen. The list of the studies is not exhaustive and comprehensive; but it supports the potential of integrating mobile phones as a learning tool to enhance language learning.

KEYWORDS

m-learning, mobile technology, mobile phone, language learning

1. INTRODUCTION

Rapid advances in information and communication technology (ICT) have produced a wide range of mobile technologies, which "are rapidly attracting new users, providing increasing capacity, and allowing more sophisticated use" (Viberg and Gronlund 2012). Society has readily accepted mobile technology and integrated it into their lives (Ally 2007). Learners, as the end users of knowledge, have experienced the developing educational trend, and the expansion of mobile technology has attracted language instructors to integrate the technology for learning languages. The main objective of the integration is to support the learning process using mobile technologies that imply mobility, portability, and personalized learning (Naismith, Lonsdale et al. 2004, Begum 2011). This paper offers an overview of published studies on language learning using mobile phones to reveal the effects of mobile phones on various language skills and other language learning aspects by examining the pedagogies adopted using the mobile phones for language learning.

2. MOBILE TECHNOLOGY, MOBILE DEVICES, MOBILE PHONE

The use of mobile technology in education offers new learning experiences and flexibility in learning – learning anywhere and anytime – with increased opportunities for decisions to be made by the learners. Furthermore, mobile technology offers ubiquitous and immediate access to information as well as saving resources. The introduction of mobile technology for learning has given rise to the term 'mobile learning', which is often abbreviated to 'm-learning'. Examples of definitions of m-learning quoted by the authors in this field include learning mediated via handheld devices that are potentially available anytime, anywhere for either formal or informal learning (Kukulska-Hulme and Shield 2008); seeking knowledge through conversations across multiple contexts among people and personal interactive technologies (Sharples, Taylor et al. 2007); as well as learning and getting information on handheld or palmtop devices as the sole or dominant technologies (Traxler 2005). For the purpose of this paper, mobile technology is defined as any forms of devices which are portable for learners to use for learning and getting information and “carries the idea of e-learning a step further by adapting its content to handheld devices” (Crescente and Doris 2011). In other words, integrating mobile devices in learning will encourage engagement and collaboration among learners and between language instructors.

Mobile devices denote technology that is portable and personal. The devices are portable as they are light; whilst personal as they are usually not shared with others and are being kept close to the owner. The technology includes “mobile phones, smartphones, personal digital assistants (PDAs) and their peripherals such as tablet PCs abd laptop PCs” (Traxler, 2005). Ogata et al. (2010) agree that the technology refers to “lightweight devices such as PDA, cellular mobile phones, and so on” (p. 8). The features of the technology extend opportunities for frequent engagement for learning regardless of connection to the Internet. The increasing number of studies being published in the past ten (10) years indicates the growing interest in mobile technology in the field of education.

The earlier designs of mobile phones (depending on context also known as cell phones, hand phones or cellular phones) were bulky and heavy devices that were used to make and receive calls only. As the technology develops, the sizes have become smaller and the weight has become lighter, representing increased portability. Nevertheless, the general features on mobile phones still include Internet-access capability, voice-messaging, short message service (SMS) text messaging, photographs, and audio/video recording (Chinnery 2006, Levy 2009) besides the communicative and computational capabilities allowing responses to user requests for connecting people or for managing personal information (Chao and Chen 2009). More recent models are known as smart phones and have smart features enabling communicative language practice for language learning as well as giving access to authentic content and task completion (Chinnery, 2006). Smart phones have computer-like functions allowing browsing and downloading of contents (Cui and Wang, 2008) in addition to free or inexpensive applications for smart phones (Kukulska-Hulme et al., 2011) and usually they have bigger screen size. Therefore, mobile technology is believed to be able to extend learning opportunities in a meaningful way (Thornton and Houser 2005) as learners determine and engage in actvities that motivate their personal learning needs and circumstances of use (Kukulska-Hulme et al., 2007, Pettit and Kukulska-Hulme, 2007).

The sense of personal belonging as well as the intimacy of the mobile phones to learners attracted earlier researchers to study the potential of mobile phones in education in general, and for language learning, specifically. The purpose of this review is to collate empirical research studies that employed mobile phones as the technology for language learning. Researchers have employed other types of mobile technology in education but this review is confined to providing baseline information on studies integrating mobile phones. Studies dated from 2004 to 2013 were reviewed in order to understand the progressive developments in the use of mobile phones to learn languages. The first author located relevant studies and collated information in relation to the progress including about the countries most prolific in integrating mobile phones for language learning, groups of participants selected in the research studies, as well as the “methodological, theoretical and linguistics knowledge trends” (Viberg and Gronlund 2012). However, there has been a gradual movement toward integrating mobile technologies into teaching and learning and Kukulska-Hulme and Shield (2008) claimed that it was due to educators who wished to understand how the technologies could be effectively used to support various kinds of learning. Their claim explains the result that found only nine (9) studies on language learning integrating mobile phones prior to 2008. Nevertheless, the number of studies increased by 83% till 2013 as more researchers developed interest in conducting similar studies.

3. METHODOLOGY

Published studies were retrieved from Google Scholar and library databases, namely Taylor & Francis, Sage Journals Online, ERIC, Springer Link. The searched keywords included mobile phone, cell phone, hand phone, handheld, mobile technology, mobile assisted language learning, mobile language learning, m-learning, language learning, English language learning, second language learning, second language acquisition, and foreign language learning. The search was limited to 2004 - 2013, inclusive, a total of 10 years. Only studies that integrated mobile phones or combined mobile phones with other learning resources for language learning were selected and a total of 50 studies was obtained.

The selection of studies was further refined to empirical studies only leaving 33 studies which were exported from the Endnote library as a .XML file for import into NVivo software, version 10 (2012), a program to analyse qualitative data. Next, the themes were determined prior to the coding by creating a Node classification. The first author coded the content of each article according to year of publication, level of participants, countries that initiated the studies, language skills and language areas learnt using mobile phone, research design adopted by the researchers and finally, research gaps highlighted by authors of the studies. Each article was read reflectively to identify content relevant to the pre-determined themes which were then highlighted and coded to the relevant node.

4. DISCUSSION

In general, the reviewed studies demonstrate the technical capabilities of mobile phones for language learning. Studies on the integration of mobile phones unanimously agree that these new learning tools are not to replace teachers or to replace the earlier forms of technology for learning (Kukulska-Hulme 2009). The mobile phones are designed to complement and support existing learning technologies for use in the learning process (Prensky 2005). The benefits include effectiveness to deliver language learning materials (Thornton and Houser 2005) and enable learning collaboration to achieve learning goals (Pena-Bandalaria 2007). This paper analyses the various approaches to integrating mobile phones to enhance language learning so as to enhance understanding of the learning practices of language learners.

4.1 Publication

Figure 1 shows the number of published studies on the integration of mobile phones for language learning that were obtained from Google Scholar and Library databases according to years. Although the number was only 2 in 2004, as shown by the trend line the number gradually increased, peaking in 2011. The graph shows no related studies identified in 2006. In 2013, there are 2 studies that have been published at the time of reporting. The gradual increase is believed to reflect an increase in interest by researchers taking the initiative to learn the new technology as well as identifying the feasible language skills or areas appropriate to use with the technology. In spite of the readiness of language teachers to adopt mobile phones for learning, learners moved faster in using the technology to support their learning process (Traxler 2005).

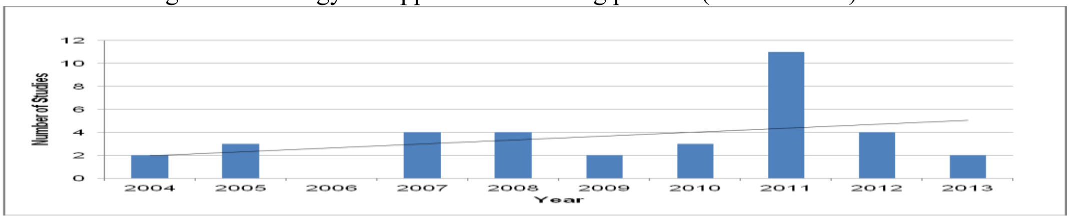

Figure 1. Trend in mobile phone for language learning research publications 2004 - 2013

4.2 Country of Studies

Studies employing mobile phones for language learning have been done across the globe from Australia to the United Kingdom. The most productive country in terms of studies published is Japan – a total of 10 studies. The least in the list with one study include Bangladesh, Canada, Hong Kong, and the Netherlands (see Figure 2).

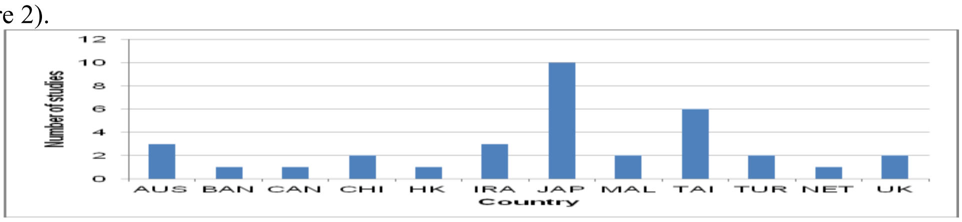

Figure 2. Countries conducted studies on mobile phones for language learning

4.3 Educational Level of Participants

The participants for the published studies have been varied. As shown in Table 1 a few studies were conducted on primary or secondary school learners. Thirty (30) of them were carried out on tertiary learners. Participants in others were employees and migrants who were selected to learn English language informally.

Table 1. Educational levels of mobile language learning research participants

Year	Author	Lower	High	Tertiary	Others
2013	Hayati et al			✓	
	Stockwell, G.			✓	
2012	Saran et al.			✓	
	Tabatabaei & Goojani			✓	
2011	Begum, R			✓	
	Edge et al.			✓	
	Gabarre et al.			✓	
	Gromik, N.			✓	
	Hsu & Lee				Employees
	Huang & Lin			✓	
	Pearson, L.				Migrants
	Sandberg et al.	✓			
	Taki & Khazaei			✓	
	Yamada et al.				Employees
	Zhang et al.			✓	
2010	Gabarre et al.			✓	
	Gromik & Anderson			✓	
	Stockwell, G.			✓	
2009	Cavus & Ibrahim			✓	
	Gromik, N			✓	
2008	Chen et al.			✓	
	Kennedy & Levy			✓	
	Lu, M.		✓		
	Stockwell, G.			✓	
2007	Ally et al.			✓	
	Cooney & Keogh			✓	
	Fallahkhair et al.			✓	
	Stockwell, G.			✓	
2005	Levy & Kennedy			✓	
	Song and Fox			✓	Adults
	Thornton & Houser			✓	
2004	Kiernan & Aizawa			✓	
	Thornton & Houser			✓	

4.4 Language Skills and Language Areas

The first author classified the learning objective for using the mobile phone in each study as either language skills or language areas. The former includes listening, speaking, reading, and writing; whilst the latter includes vocabulary, idioms, and grammar. As shown in Table 2, the majority of the studies were devoted to vocabulary learning as the most frequently selected language skill with a total of 18 studies. For example, Stockwell (2013) conducted a study combining vocabulary learning with listening skills using mobile phones. Vocabulary is the basic building blocks of the target language before developing sentences. Second language learners learn vocabulary for them to be able to deliver using chunks of words with simple meanings. The early design of mobile devices that had limited physical and technical functions were appropriate to deliver vocabulary content.

The next most popular language skill reported in the studies was speaking, with a total of 7 studies. Kukulska-Hulme (2008) raised concern at the rare studies of mobile phone use to develop oral interaction though the technology has the affordance, and prior to 2008 only one study (Cooney and Keogh, 2007) was conducted on speaking skills. Other studies focused on English for specific purposes, for instance, English for tourism (Hsu, 2012), idioms (Thornton and Houser 2004, Hayati, Jalilifar et al. 2013), grammar (Ally, McGreal et al. 2007, Kennedy and Levy 2008, Gabarre and Gabarre 2010) and prepositions (Begum 2011).

The early designs of mobile technologies had small screen size limiting the presentation of graphics (Albers and Kim, 2001); nevertheless, Colpaert (2004) raised his concern on the output from the mobile phones as focusing more on the visual aspects instead of verbal aspects. Many past studies required learners to read from the screen of mobile phones rather than listening to audio from the mobile phones. This, according to Colpaert (2004), was a disadvantage for language learning. In addition to vocabulary learning, mobile phones were integrated in language learning using the Short Message System (SMS) feature to deliver content knowledge (Lu 2008, Cavus and Ibrahim 2009).

Based on this review it can be concluded that the integration of mobile phones for language learning was not used on its own only but on a few occasions the technology had also been incorporated with other learning resources with the objective of enhancing learning. Similarly, each of the learning skills was either individually learnt on the mobile phone or the specific language skills were learnt together with other language areas. In general, the aim is still to support the planning and managing of learning strategies and activities.

Table 2. List of language skills and language areas

		Language skills					Language
Year	Author	L	S	R	W	V	areas
2013	Hayati et al						Idioms
	Stockwell, G.	✓	✓			✓	
2012	Saran et al					✓	
	Tabatabaei & Goojani					✓	
2011	Begum, R						Preposition
	Edge et al.		✓				
	Gabarre et al.						
	Gromik, N		✓				
	Hsu & Lee						ESP
	Huang & Lin			✓			
	Pearson, L.						English
	Sandberg et al.						ESL
	Taki & Khazaei					✓	
	Yamada et al.	✓					
	Zhang et al					✓	
2010	Gabarre et al.		✓				Grammar
	Gromik & Anderson		✓				
	Stockwell, G.					✓	
2009	Cavus & Ibrahim					✓	SMS
	Gromik, N		✓				
2008	Chen et al					✓	
	Kennedy & Levy					✓	Grammar
	Lu, M.					✓	SMS
	Stockwell, G.					✓	
2007	Ally et al.						Grammar
	Cooney & Keogh		✓				
	Fallahkhair et al.			✓		✓	
	Stockwell, G.					✓	
2005	Levy & Kennedy					✓	Italian
	Song and Fox					✓	
	Thornton & Houser					✓	Idioms
2004	Kiernan & Aizawa					✓	Task-based
	Thornton & Houser					✓	

4.5 Research Design

The options for research procedures include quantitative, qualitative, or mixed methods. Surveys are one of the instruments used to collect numerical data, interviews are examples of narrative data, whilst combining both survey and interview is the basis for mixed methods designs offering reliable results for more complex contexts. The design chosen for any particular research has a rationale based on the objectives of the research. With reference to Table 3, the most popular research design for the 33 studies was quantitative. In other words, pre-test in the form of survey in relation to specific language skills was administered at the beginning of the study and post-test was administered after the treatment of using mobile phone during the course of learning. None of these studies adopted qualitative research designs which future researchers can consider in order to gain additional insights into the context of discussion.

Table 3. List of research design

Year	Author	Qualitative	Quantitative	Mixed-methods
2013	Hayati et al.		✓	
	Stockwell, G.		✓	
2012	Saran et al.		✓	
	Tabatabaei & Goojani		✓	
2011	Begum, R.			✓
	Edge et al.			✓
	Gabarre et al.			✓
	Gromik, N.			✓
	Hsu & Lee		✓	
	Huang & Lin		✓	
	Pearson, L.			✓
	Sandberg et al.		✓	
	Taki & Khazaei		✓	
	Yamada et al.		✓	✓
	Zhang et al.		✓	
2010	Gabarre et al.		✓	✓
	Gromik & Anderson		✓	
	Stockwell, G.		✓	
2009	Cavus & Ibrahim		✓	
	Gromik, N.			
2008	Chen et al.			✓
	Kennedy & Levy		✓	
	Lu, M.			✓
	Stockwell, G.		✓	
2007	Ally et al.		✓	
	Cooney & Keogh			
	Fallahkhair et al.			✓
	Stockwell, G.			✓
2005	Levy & Kennedy			✓
	Song and Fox			✓
	Thornton & Houser		✓	
2004	Kiernan & Aizawa			✓
	Thornton & Houser		✓	

4.6 Future Research Directions

The following section presents future research areas suggested by authors of the past studies. First, empirical studies on the interaction of text literacy and standard English literacy have been few among them (Geng 2013) despite the assumption that tertiary learners have achieved a proficient level of academic literacy in reading and writing. With the assumption that different learning strategies will be adopted in m-learning contexts with the technology in hand, Geng (2013) suggested the need to study attitudes of learners when using text messages in m-learning and how their attitudes influence their practice. Similarly, Stockwell (2013) proposed future research on the engagement of learners in m-learning outside the classrooms since m-learning offers flexibility in learning. It is believed that mobile phones can be leveraged to support formal and informal learning.

Due to inconsistent findings by earlier studies on SMS, Hayati et al. (2013) proposed more studies using SMS in formal language learning; similarly Begum (2011) recommended further exploration and more empirical studies on the effectiveness of SMS for learning language. Nevertheless, past studies on SMS should be referred to identity the similarities and differences of the research context.

A feature in mobile phones is video recording and Thornton and Houser (2004, 2005) raised the issue of the least frequent activity using the video recording feature. Much later, Gabarre and Gabarre (2010) and Gabarre et al. (2011) addressed this issue by administering a study on a group of French language learners. However, the benefits of learning by integrating both audio and video features in mobile phones are of future interest (Gromik 2011, Saran, Seferoglu et al. 2012).

Social interaction promotes learning; consequently learning with peers reduces the emotional burden. In line with m-learning, a small number of studies have included the element of collaborative activities (Kukulska-Hulme and Shield 2008). Therefore, more studies on ways to use mobile phones in collaborative learning are encouraged (Clough, Jones et al. 2008).

A formal theory of mobile language learning is yet to be developed according to Joseph and Uther (2006) and Kukulska-Hulme (2008) even though Sharples et al. (2007) postulated a general theory of mobile learning. In addition, Lu (2008) suggested a study on an effective self-study approach to learn vocabulary among vocational high school students based on review of past studies. Similarly, Gromik (2010) highlighted the need for more studies on using mobile phones as a learning tool in general. Lan (20047) proposed studies using mobile phones to develop reading skills; however, based on the search for this review, only two studies were conducted (Huang and Lin 2011, Geng 2013). This can be attributed to the screen size of the earlier designs of mobile phones in contrast to the current designs, which have larger screen size that are more convenient for reading. Only two studies were conducted on listening skills since (Yamada, Kitamura et al. 2011, Stockwell 2013) and none for writing skills. In relation to writing, writing words or short phrases should be easier than writing long sentences using the restricted keyboards on mobile phones.

5. CONCLUSION

To summarise, this paper has reviewed studies using mobile phones in language learning contexts. The mobile phones are accepted by learners of second language learning and past studies have substantiated their integration to improve language skills and related language areas. Learning can take place in formal or informal settings allowing learners to learn at their own time and anywhere. With recent design and features of mobile phones, future studies on improving the language skills are recommended. Other potential areas of research include learning strategies, learner attitude and collaborative learning. Mobile phone is only a learning tool to aid language learning; therefore, future studies should also examine its integration in second language acquisition theories.

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OVERLAPPING CHAT'S ACCESSIBILITY REQUIREMENTS BETWEEN STUDENTS WITH AND WITHOUT DISABILITIES DUE TO THE MOBILE LIMITATIONS

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ABSTRACT

The use of Chats has been extended to mobile-learning (m-learning) environments in the last decade. Students and teachers can communicate in real time and they do not need waiting till their next tutoring date to solve their problems and doubts. However, Chats have many accessibility barriers and many students cannot use this collaborative tool. These accessibility barriers affect students with disabilities but students without disabilities can face the same accessibility problems due to the restrictions and limitations of handheld devices. Previous studies have improved the accessibility issues of Chats for a specific environment or disabilities but none of them is focused on the limitations that students without disabilities can face when they are using Chats in handheld devices. This is the main aim of this research; specify how the Chats' accessibility requirements have been elicited and analyze the benefits that the obtained requirements can produce for people without disabilities in m-learning contexts.

KEYWORDS

Accessibility; m-learning; handheld devices; Chat; disability; requirements

1. INTRODUCTION

The use of collaborative tools is rising up and students are used to diary use these new environments. One of these collaborative tools is the Chat, which allows students and teachers to exchange instant messages easily. Chats are really useful in m-learning environments for students and teachers to exchange information [1]. However, they present many accessibility problems [2] which do not allow users to use the chat properly and completely. Users with disabilities cannot use them because of barriers such as: problems to follow the flow and rhythm of the conversations [3], problems with the new updated content [4] or problems related to the use of technologies improperly [5]. Furthermore, people without disabilities can experience these problems too because of the limitations and restrictions of handheld devices [6]. For example, if students use a handheld device, they could have problems when they are typing because of the size of the keys in the small keyboard. It is the same problem that people with motor impairments face when they input text in handheld devices or in desktop computers.

This research aims to specify the main accessibility requirements that a Chat should have to be accessible for m-learning environments as well as the benefits that students without disabilities can get when they use Chats in m-learning. Thus, this paper explains how the requirements have been elicited and it also analyzes if these requirements are also useful for people without disabilities who use Chats in handheld devices for m-learning.

This article is divided into the next sections: State of the Art; Requirements for an accessible Chat in m-learning environments and Conclusions. The first section establishes the main accessibility problems of Chats as well as previous Chats which have tried to improve the accessibility. Later, the functional requirements which improve the accessibility for Chats in m-learning environments are specified. And finally, the conclusions and future work about the research are explained.

2. STATE OF THE ART

Many tools such as: blogs, forums or Chats are used to support collaborative learning [7]. One of these collaborative tools, Chat, is a useful tool to communicate with other students or with their teachers in learning environments [8]. However, Chats cannot be used by everybody because of their barriers and because they even have more accessibility problems than other information technologies [9]. Moreover, these problems can affect to people without disabilities too because of the context and use of handheld devices [6]. This section explains the main accessibility problems that Chat's users have as well as previous studies which have tried to improve the Chats' accessibility of learning environments.

3. CHAT ACCESSIBILITY PROBLEMS

Some of these barriers are related to the use of some assistive technologies. If the website auto-refreshes continuously, it causes the screen reader restarts [4] and Braille-display users experience problems because the assistive technology reproduces the new sentences even if the previous sentence has not been spoken completely [10]. Other problems are related to the flow and rhythm of the conversation. Learners with dyslexia, for instance, can feel embarrassed or shamed because they have some interaction problems [11]. Besides, if one of the emitters is not able to write quickly because of his learning disabilities or due to the use of assistive technology as screen readers, they could not be able to follow the conversation [3].

From the point of view of chats in handheld devices, users could experience more restrictions due to the technological limitations of handheld devices [12]. For instance, desktop users with visual impairments can face problems to access to information of the images, if they do not have alternative text as indicated by accessibility standards. This problem is similar to the problems that low band width provokes when images cannot be download and do not have alternative text. Thus, despite using different handheld devices, mobile Web users and impaired desktop users share similar problems [13].

3.1 Previous Accessible Chats

Previous researches try to improve some accessibility problems that users face when they use chats. With regard to the use of chats in e-learning environments like Learning Content Management Systems (LCMS), some LCMSs have tried to implement more accessible chats in their tools. For instance, Moodle 2.3 provides an accessible interface which does not use frames and Javascript technology. Besides, the auto refresh period of time can be specified [14]. Atutor has developed a chat, Achat[1], to solve some technological aspects which can be used by users who use assistive technology and provides functionalities such as: specify the auto refreshing time or refresh messages manually. Furthermore, Blackboard[2] improved the accessibility of its chat creating an Accessible Chat alternative which better support screen readers [15]. Another example of implementation of an accessible chat is the chat provided by eCollege[3] which accomplishes the Section 508 Act and is more usable with assistive technologies [15].

Considering Chats in handheld devices, AssistiveChat[4] provides new features for people with speech disabilities. For instance, the chat suggests words to the user, there are some sentences predefined and it converts the text-to-speech. Moreover, IM prototype [16] specifies the features that a mobile Chat should have such as: presence awareness, asynchronous chat or multi-user chat. However, it does not specify anything related to accessibility. The PictoChat [17] uses a chat in a learning environment through a Nintendo DS console. This chat allows users to write or draw on the screen and communicate with their colleagues but it does not consider accessibility in its design.

These studies try to improve the accessibility of Chats in e-learning and m-learning environments, but none of the previous proposals avoids all the Chat's accessibility barriers. For example, they are focused on specific situations and none of them have tried to improve the accessibility for all students because they are

[1] http://atutor.ca/achat/
[2] http://www.blackboard.com/
[3] http://www.ecollege.com/
[4] http://www.assistiveapps.com

focused on specific disabilities. Furthermore, none of them have specified the main accessibility requirements that an accessible chat should have for e-learning or m-learning environments.

Then, one of the main aims of the research presented in this paper is to study which are the Chat's accessibility requirements for everybody in m-learning environments. Besides, this paper specifies which of them could benefit students without disabilities who experience accessibility barriers because of the handhelds' restrictions and limitations.

4. REQUIREMENTS FOR AN ACCESSIBLE CHAT IN M-LEARNING ENVIRONMENTS

The main requirements that a Chat should have to be accessible in m-learning environments for everybody have been obtained basing on the Human Computer Interaction (HCI) and Software Engineering (SE) disciplines [2].

Moreover, these requirements are analyzed from the point of view of the similarities between web users with disabilities and mobile web users without disabilities; to conclude, if they could be helpful for people without disabilities that use Chat's in m-learning environments. Next sections specify the main SE and HCI techniques used in the elicitation phase as well as the analysis of the functional obtained requirements, which improve the accessibility, for people without disabilities.

4.1 Requirements' Elicitation

Different HCI and SE techniques have been used to obtain the main accessibility requirements that a chat should have to be used in m-learning environments. Both disciplines are combined in order to create more accessible software which involves users in the whole process. The first discipline is needed because this study is part of a research which main goal is to provide a model-based design of an accessible Chat. And the second discipline is used because the research aims to follow a User-centered Design (UCD) involving users in the whole process. Basing on the studies [18] and [18] which specify the main methods used in SE and HCI discipline respectively, the methods which better fit the necessities of this research have been selected.

Firstly, the stakeholders are established and for this research they are teachers and students. They can interact with each other and teachers do not conduct the conversations and way of learning. Thus, students and teachers will be able to execute the same functionalities. Moreover, to obtain a good solution proposal, a specific domain has been chosen to elicit accessibility requirements. Then, the domain is m-learning environments. Next, users have been involved in the elicitation phase and they have participated through questionnaires, user interviews and brainstorming. Other techniques like *Personas* [19] and *Scenarios* [20] have been used to obtain accessibility problems that people could face. Furthermore, existing competitors and systems have been analyzed to obtain the main accessibility problems that they face as well as to check how they have solved specific accessibility barriers. A part from following these techniques, the requirement elicitation is based on standards and guidelines related to learning environments and accessibility such as: Web Content Accessibility Guidelines (WCAG 2.0) [21], Mobile Web Application Best Practices 1.0 [22] or Universal Design Learning [23]. Finally, all the obtained requirements are categorize and classified. Next, the Table 1 shows the methods used and its discipline/s.

Table 1. HCI and SE Methods Used in the Requirements Elicitation Phase

Methods	HCI	SE
Identify stakeholders and users and stakeholder analysis	✓	✗
Context of use analysis	✓	✗
Brainstorming	✓	✓
User interviews	✓	✗
Questionnaires	✓	✗
Existing system/competitor analyzes	✓	✗
Standards and guidelines	✗	✓
Personas	✓	✗
Scenarios	✓	✗
Categorize requirements	✓	✗

Considering the HCI and SE disciplines and using the techniques specified previously, the requirements for an accessible Chat in m-learning environment have been obtained [2]. Some of these requirements have been improved or added in order to improve the user's experience of students with disabilities. In this paper, we are going to focus on these requirements, the functional requirements which improve the accessibility, see Table 3. Next, these requirements are analyzed to specify if they could be useful for people without disabilities in m-learning environments too.

4.2 Analyses of the Requirements

After obtaining the requirements that a Chat should have to be accessible in m-learning for students with disabilities, they have been analyzed in order to check if they could be beneficial for people without disabilities who use Chats in m-learning.

4.2.1 Overlapped Accessibility Problems for People with and without Disabilities

Basing on the limitations that users with disabilities could have, the restrictions of handheld devices [6] [13] and previous studies which make a parallelism between the problems of people with and without disabilities [24][25][26][27], the Table 2 is created. This table shows the overlapped problems that people with disabilities can have and the problems that people without disabilities could experience in m-learning due to the handheld's limitations when they want to access to the same inaccessible content. Moreover, it is important to emphasize that some of these accessibility barriers are present in old devices only. However, the students sometimes have not the opportunity to have the last generation of mobile devices and software.

Table 2. Accessibility Problems Faced by People with Disabilities that are Similar to the Barriers that People without Disabilities face due to the Handheld Devices Limitations

Problem	Impairment	Handheld
Color	Colorblind or blind	Limited color palette or sunny places
Large content	Screen magnifier users	Small screen
Multimedia with no captions	Hearing problems	Turn off sound or noisy places
Warnings with audio	Hearing problems	Turn off sound or noisy places
Non-text-objects	Blind user or unsupported technology	Switched off images or unsupported technology
Text Entry	Motor and cognitive disabilities	Small keypad, gloves, unsteady hand or in motion.
Using tables without a logical reading order	Blind user	Small screen and restructured content
Visual information	Blind user	Not CSS support
No keyboard accessible	Motor and visual disabilities	Device has no mouse
Scripting	Not support of scripting	Not support of scripting
Use of plugins	Plugin turned off or not compatible	Plugin turned off or not compatible
Inappropriate page title	Screen reader users	Page title truncated
Content cannot navigated in a logical sequence	Blind and motor impairments	Not pointing devices
Non descriptive link labels	Screen reader users	Link target
Complex language	Cognitive and hearing disabilities	Distracted conditions or in motion.
New windows	Visual and cognitive disabilities	Small screen or distracted conditions
New content	Reading, learning and cognitive disabilities	Small screen, distracted conditions or environments with weak light.
Unsupported markup	Assistive technologies or browsers	Browser
Unsupported scripting	Assistive technologies or browsers	Turned off or not supported
Pointing	Motor and visual disabilities	Small keypad, gloves, unsteady hand, in motion, distracted conditions or eyes-free interactions
Completion times	Motor disabilities	Small keypad, gloves, unsteady hand, in motion or distracted conditions.

As it has been shown, there are many limitations that make users have barriers when they are using their handheld devices. Considering the limitations that people without disabilities could have, Table 2, these limitations could be grouped into:

1) Hardware limitations (HW): Small screen or keypad, not pointing devices, the device has no mouse
2) Software limitations (SW): unsupported technology, browser, scripts, CSS.
3) Content information (Cont.): link target and page title truncated.
4) User necessities or Preferences (UP): turned off images, sounds, or plugins.
5) Environment Limitations (EL): sunny, light, crowd, distracted or noisy environments and user situations like unsteady hand or in motion. In general, places where users' abilities could be reduced.

4.2.2 Improved and Added Functional Accessibility Requirements for Students with Disabilities and for Students without Disabilities in m-learning Environments

Considering the overlapped problems specified in the previous section, it could be indicated that the improved accessible functional requirements for people with disabilities could help students without disabilities to use the Chat in m-learning environments because of the limitations and restrictions of the Chats. For instance, the *Stop Auto Refresh* functionality is useful [28] for people with visual, motor and cognitive or learning disabilities because it allows them to stop the reception of new messages when they are overwhelmed (Related to *New Content problem,* Table 2). Thus, students without disabilities, who are using the Chat in small screens, distracted conditions or environments with weak light could face the same barriers and could get a benefit too.

The *Clean Message* functionality, which allows users to clean all the messages showed on the screen, is another example. The functionality could be useful for screen magnifier users because this assistive technology increases the size of the elements and consequently, the user cannot see all the messages in the screen (Related to *Large Content problem,* Table 2). Users without disabilities could get a benefit of it too when they are using the Chat in a handheld device because of the screen's size.

Next, Table 3 summarizes the accessibility requirements useful for students with disabilities that could be useful for other students in m-learning due to the limitations of handheld devices basing on the overlapped problems specified in the previous section. Besides, it shows the improvements that these requirements provide as well as the problems that they solve basing on Table 2. The following columns specify when these requirements could be useful for the students without disabilities (basing on the categories classified in the previous section).

Table 3. Accessibility Requirements Useful for Students with Disabilities and M-Learning Students without Disabilities

Accessibility Req.	**Description**	**Problems Solved**	**HW**	**SW**	**Cont.**	**UP**	**EL**
Add an Interlocutor	Students could stop the new interlocutor addition to the conversation.	Large Content Text Entry	✓	✗	✗	✗	✓
Predefined Sentences	Students can select predefined sentences provided by the system.	Text Entry	✓	✗	✗	✗	✗
Add File	The student should specify a description for the uploaded file and the system informs the students about the size's file.	Non-Text Objects	✗	✓	✗	✓	✗
Add URL	The student should specify a summary of the URL and its language to advice other students.	Non descriptive link labels	✗	✗	✓	✗	✗
Stop Auto Refresh and Refresh Conversation	Allow students to pause and refresh the conversation.	New content Completion times	✓	✗	✗	✗	✓
Convert Conversation	Transform the conversation to other formats like audio or	Pointing	✗	✗	✗	✗	✓

Accessibility Req.	Description	Problems Solved	HW	SW	Cont.	UP	EL
	braille						
Last Messages	Show only last messages on the screen	Large Content	✓	✗	✗	✗	✗
Time Refresh	Show new messages in a specific period of time	New content Completion times	✓	✗	✗	✗	✓
Number Messages	Show a specific number of messages on the screen	Large Content New content Completion times	✓	✗	✗	✗	✓
Messages' Order	Show last or new messages at the beginning	New content Completion times	✓	✗	✗	✗	✓
Clean Messages	Allow students to clean the messages which are showed in the screen.	Large Content	✓	✗	✗	✗	✗
Reception Messages	Inform students when the message has been delivered	Not overlapped	✗	✗	✗	✗	✗
Writing	Inform students when other users are writing.	New Content Complex Language	✓	✗	✗	✗	✓
Check Spelling	Inform students about grammatical errors.	Text Entry	✓	✗	✗	✗	✗
Modify User Name	Change large names of students	Non descriptive link labels Large Content	✓	✗	✓	✗	✗
Translate	Translate messages if the sentence language is different to the predefined language.	Complex Language	✗	✗	✗	✗	✓
Show Previous Messages	Allow students to show previous messages	Large Content	✓	✗	✗	✗	✗
Tag Conversation	Catalog the conversations into categories	Large Content	✓	✗	✗	✗	✗

5. CONCLUSION

Creating accessible m-learning environments for students with disabilities is really useful and necessary to protect the persons' rights. It could help to prevent the accessibility barriers that unfortunately still exist in educational environments. However, these improvements could be a benefit also for people without disabilities that can experience the same accessibility barriers because they are using a handheld device.

This research specifies how the Chat's accessibility requirements for m-learning have been elicited and specifies which requirements are useful for students without disabilities who use Chats in m-learning environments due to the restrictions and limitations of handheld devices. For example, the feature which helps users to stop the reception of new messages is useful for students with disabilities and for students who are in distracted conditions or in motion.

In the future, these requirements will be evaluated with users to assure that they are useful for m-learning students without disabilities.

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UML Quiz: AUTOMATIC CONVERSION OF WEB-BASED E-LEARNING CONTENT IN MOBILE APPLICATIONS

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ABSTRACT

Many educational institutions use Learning Management Systems to provide e-learning content to their students. This often includes quizzes that can help students to prepare for exams. However, the content is usually web-optimized and not very usable on mobile devices. In this work a native mobile application (*UML Quiz*) that imports quiz content from Moodle and adapts it for a mobile environment has been developed. The result is highly usable and promising. The existing teaching content can be easily used in the new system by offering advantages of mobile applications. In this paper, the design decisions for *UML Quiz* and the usability optimizations to the content are presented. The results are evaluated and further possible improvements are discussed.

KEYWORDS

E-learning, m-learning, mobile, usability, native, automatic content adaption, automatic content conversion.

1. INTRODUCTION

Many educational institutions use web-based Learning Management Systems (LMS) to provide e-learning content to their students. Popular examples include Moodle, Blackboard, Desire2Learn, and ILIAS. Besides being a well-known and mostly used system Moodle "is not intrinsically designed to be accessed through mobile devices, but the constructivism pedagogy supported in Moodle VLE could be applied to design the interaction in m-learning" (Hewagamage et al., 2012, p.2). Moodle does not fully support JavaScript. This makes it difficult to access via mobile devices.

Most of the LMS platforms include quiz modules. These quizzes can, for example, help students to prepare for exams. However, these platforms rarely offer easy access for mobile devices, especially not with native applications. Native applications offer numerous (usability) advantages over web-based apps, especially if they are running on mobile devices. However, the creation of native apps is time-consuming and expensive.

In this work we propose a native mobile quiz application (*UML Quiz*) that can deal with web-optimized e-learning content in a way that preserves usability and encourages easier learning. It is accompanied with an automatic system that converts the web-optimized data into a mobile-friendly format, both in size and layout. A few optimizations and enhancements to the data are being used to make the application compelling and easy to use, even though the data was not originally prepared for this specific device.

UML Quiz has been developed natively for iPhone and iPad to use for teaching at Vienna University of Technology (TU). The course supported by *UML Quiz* is about basics of the Unified Modeling Language (UML) to students of computer science and business informatics. In this course, a modified version of Moodle (TUWEL) is being used to display quizzes to the students, which they can use to prepare for exams. These quizzes include lots of diagrams of different sizes and very long questions and answers. The system we propose imports the existing, web-optimized data from TUWEL and deals gracefully with these types of questions. It allows the university to keep using the existing data and displays it in a highly usable manner on a mobile screen.

In the next section we briefly introduce relevant related work before we analyze *UML Quiz* in this research scope. We also will touch upon other work that adapts web-content for mobile devices. Section 3 presents implementation details of *UML Quiz* with a focus on design and usability decisions. Section 4 shows the evaluation of the results, which we further explored for future work.

2. RELATED WORK

In this section, we want to show some other systems developed so far. Second, we want to focus on usability and content conversion in such systems. We will also highlight the differences to our system *UML Quiz*.

Despite the fact that "accessing learning content through mobile devices is not very comfortable" (Hewagamage et al., 2012, p.32) and e-learning content can be accessed the best through desktop interfaces, the advantages of mobile applications especially for learning cannot be underestimated. There are several systems that are implemented as mobile applications, mainly quizzes for teaching.

The group of Schön et al. (2012a, 2012b) developed a mobile quiz application for the University of Mannheim. Its main purpose is capturing classroom feedback from the students during courses, which is the main difference to *UML Quiz* that mainly assists students in the preparation process for exams. It is a web-based application and supports dealing with multiple- and single-choice questions. The application's data is formatted to fit the mobile screen. Question texts are kept short, possible answers are usually single words, and images are kept at a size which are clearly visible on a mobile screen. Another system was developed to support learning foreign languages (Tabata et al., 2010). It uses the same approach as the one from the University of Mannheim. There are text-based questions and answers whereas texts are kept very short. The system supports only multiple-choice questions.

iClass is a further system for mobile learning (Eyhab and Qusay, 2012). In contrary to the systems above, it hasn't been developed on top of an existing university infrastructure, but instead has been designed for mobile devices from scratch. However, it is a web-based implementation using the phone's browser, and this is the main difference to *UML Quiz*. The decision for this technology was made for the reason to support a variety of devices. Authors did not want to "enforce a particular device" (Eyhab and Qusay, 2012, p.591). At the same time, they are aware of the reduction of usability because of not taking care of the platform and the follow up limitations in the interaction with the system.

The multiple-choice questions realized in (Montanaro, 2012) resemble closely to the structure of *UML Quiz*. The content presented is dynamic, the text can be displayed in multiple rows, and feedbacks are being shown after having solved the question.

UML Quiz closely follows the general structure of most of these systems, and in some aspects improves upon them. One of the main differences is that *UML Quiz* is implemented natively, whereas most of these systems are web-based. We found the following systems as native mobile applications that we unfortunately could not test because of the license restrictions: Upside2Go with a quiz module, Mooestro without a quiz module by focusing on orientation at campus and while registering for lectures, Pearson Learning Studio and OpenClass as a very popular LMS, MOBL21 including multimedia to its quiz module, which is the closest to our *UML Quiz* among all. Furthermore we found Adobe Captivate and Articulate as HTML5-based systems, again with no open access. Other systems available like Quiz and Flashcard Maker, Edmodo, Blackboard Mobile, or Socrative are not described here because of the lack of usability or features they offer.

The second important characteristic of *UML Quiz* is the focus on usability and easiness. Even though the most of the mentioned systems have been developed with the aim to support mainly mobile platforms (Wasserman et al., 2010), they are not exhaustively using the possibilities of a mobile device. This is only possible if the system is developed natively for specific devices, what we do with *UML Quiz*.

KnowledgePulse (Bruck et al., 2012), Quizzer (Giemza et al., 2012) and MLEA (Castillo et al., 2012) are also native applications for iOS and Android as *UML Quiz*. They also constrain the content of the data to fit certain screen size of mobile devices. This scalability feature is a limitation of native applications (Giemza et al., 2012) and a challenge to expand the system to another platform. *UML Quiz* would have to be completely re-written in Java to work, for example, on Android.

Contrary to scalability, usability is an important advantage of native applications. Native applications usually perform much faster than web-apps – especially scrolling is much more responsive (Charland and Leroux, 2011). Native apps enable access to device-specific APIs, like Apple's Core Data, which has been used in the development of *UML Quiz*. They allow for offline use, which is particularly useful in the context of mobile learning. However, web-apps have the advantage of being platform independent and the development costs are usually much lower than the cost of building native apps (Selvarajah et al., 2013).

There are other systems adapting web-content for mobile devices (Casany et al., 2012), some specifically for e-learning material (Gutierrez-Martinez et al., 2012) However, these works concentrate mainly on the format conversion and the interoperability between different learning management systems, but they do not take the usability implications into consideration.

Romero et al. claim that when creating m-learning systems "designers of both software and content have to consider the special restrictions associated to their use" (2010, p. 375). The limiting factors are among others screen size, resolution, and special input mechanisms. Guidelines for designing usable educational material suggest that the display area should not exceed the screen size and the content should be segmented into smaller chunks. Additionally extensive scrolling and the number of clicks should be well designed and one should pay attention on the amount of relevant information on each page. Further points of importance are highlighted like clear navigation structures, consistency of interface elements, and typeface.

3. UML QUIZ: CURRENT IMPLEMENTATION

UML Quiz was designed to automatically import the web-based quizzes from Moodle and display them in a highly usable manner on a mobile screen. However, as Moodle supports free HTML formatting of the content (text of any length and any number of images), constraints and design goals had to be defined. We did not want to restrict the length of the question or answer text, as the system should be able to deal with existing content. However, we constrained the use of images to one image per question and one image per possible answer. *UML Quiz* automatically discards questions that do not follow these constraints. We also wanted to ensure that navigation between questions is fast and easy. Romero et al. (2010) prefer paging over scrolling when navigating, so in *UML Quiz* each question consists of a screen-full content. We implemented a simple swipe gesture for navigation between questions. The overall design is focused on providing as much space for the content as possible and minimizing the space that UI-elements take up. We wanted to make sure that most elements of a question (question text, images, and possible answers) are visible at the same time.

Our system uses Moodle's export feature to obtain quiz data in the Moodle XML format. We then parse the data and import it into our native mobile application, *UML Quiz*. Upon import, the content is optimized for use on mobile devices. See Figure 1 for an architectural overview.

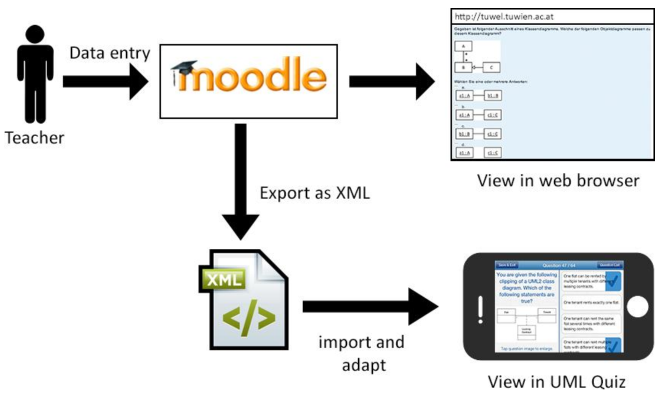

Figure 1. Architectural overview.

In TUWEL (a modified version of Moodle at Vienna University of Technology) different question types are presented to the user. The text in all types can be formatted freely with standard HTML tags such as bold and italics. Any number of images can also be added at any point. Each question type has been individually adapted for use in the native app. The question and possible answers are presented as HTML-formatted text to the user. Usually, questions contain at most one image in the question text and one image per answer. However, in TUWEL, there are no constraints to enforce this rule, and theoretically more images are possible. See Figure 2 for an example, which illustrates how this is solved in TUWEL and implemented in *UML Quiz*.

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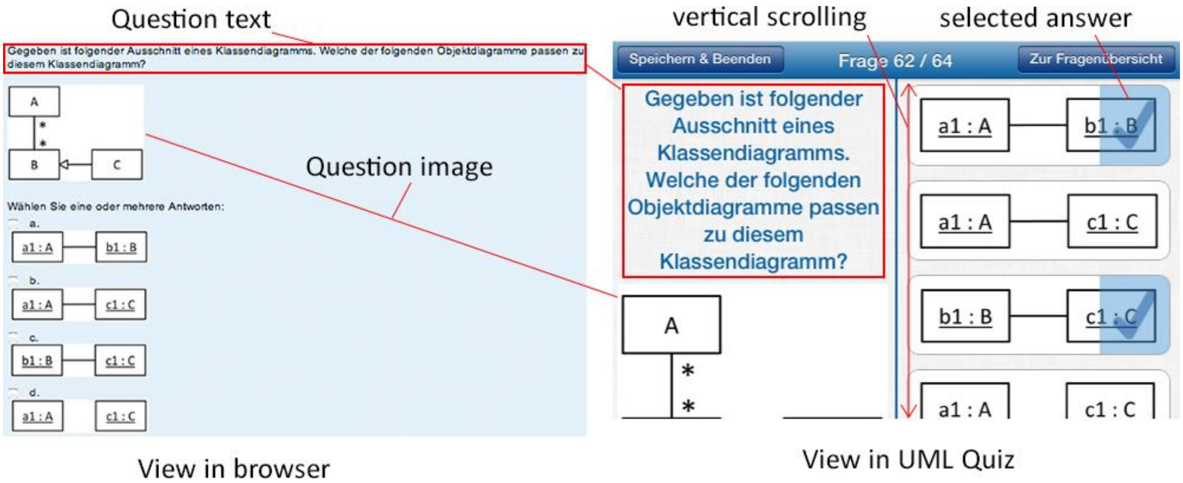

Figure 2. Multiple-choice questions in Moodle and *UML Quiz.*

The Figure 2 also shows the same question after it has been imported into the mobile application. The interface is forced into landscape mode, splitting the screen's content into half. On the left side, the question text and, if available, a single question image are displayed. Tapping the image enlarges it to full screen, also enabling zooming and panning with two-finger pinch gestures. On the right side, the possible answers are displayed, some of which are selected in Figure 2, which is visualized with blue checkmarks. Both sides of the screen are individually scrollable vertically, if the text is longer than screen size allows for.

In TUWEL, some questions are implemented with a dropdown list. In these questions, a general text that explains the task is presented to the user (e.g., "Select the right answer from the list"). Then, a number of subquestions is being shown. For each of these subquestions, a drop-down list is displayed. The possible choices of this list are the same for all subquestions. See Figure 3 for an example.

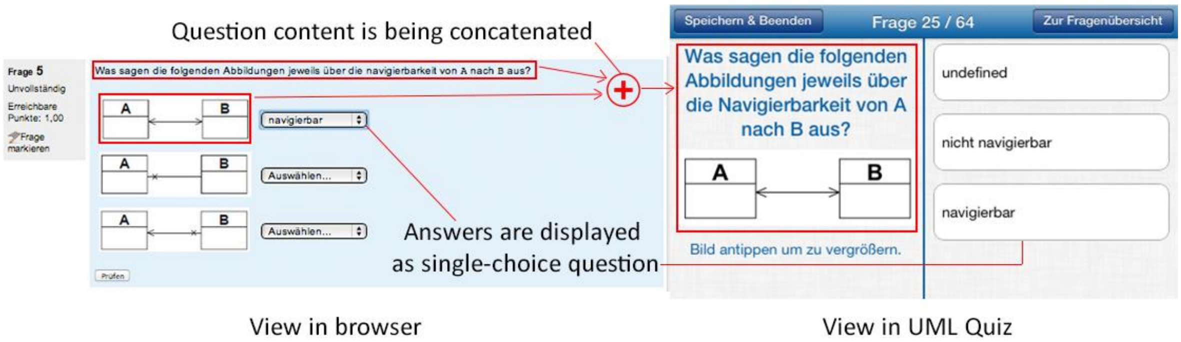

Figure 3. Optimization of drop-down questions.

On touch-screen devices drop-down lists are usually implemented with picker control elements. Early iterations of *UML Quiz* have implemented this control element to support drop-down questions, however, the picker takes up so much screen space, that all the other content on the screen is occluded. To solve this problem, the following optimization has been used. Upon importing the TUWEL data, questions of the drop-down type are split into numerous single choice questions. Figure 3 shows a drop-down question with images in TUWEL and compares it with the first part of the same question split into a single choice question in *UML Quiz*. We interpret the possible selections from the drop-down list as possible answers. The question text is constructed by concatenating the general instruction text of the drop-down question with the text or image from the specific question.

While this approach works much better than the use of the picker control element, it doesn't quite fit some of the existing data. In the TUWEL screenshot above, the general text is written in plural, as it refers to multiple images, however, in *UML Quiz*, only one image is visible. In this case the consequences of this issue are harmless, as it merely might confuse users. However, in other cases, this problem might completely transform the original sense of the question. As this limiting problem is caused by semantics, it is not possible to solve it in an automatic fashion; it requires a manual re-work of the questions.

Another question type is presented with a text box in TUWEL. These questions do not offer users a list of possible answers to choose from. Instead, they are prompted to enter the answer in a text box. The question itself is presented to the user with text, an image, or both, and usually requires them to calculate a number or a certain answer. See Figure 4 for an example and a comparison with the mobile application. As visible in the screenshot, a simple text field has replaced the left side of the screen. Tapping it reveals the on-screen keyboard, as well as a button to dismiss it again.

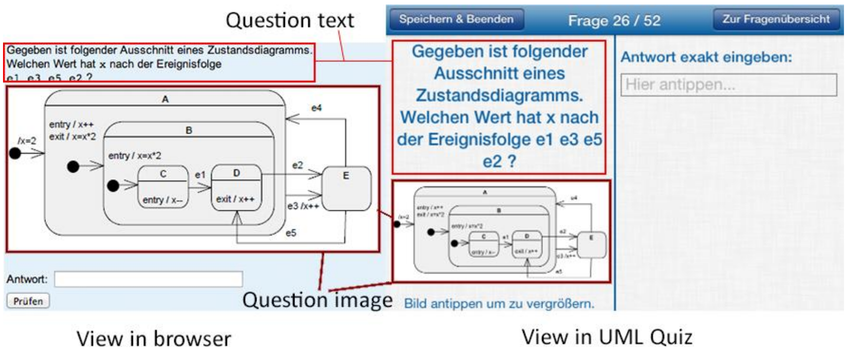

Figure 4. Comparison of text-box questions.

After a question has been solved, its correct answers are revealed (see Figure 5). Another feature of the system is the explanation text that is displayed to users after they finish a quiz. Its purpose is to provide additional information about the question or the possible answers. The text may also explain why certain answers are correct or incorrect. It is also possible to include images in the explanation.

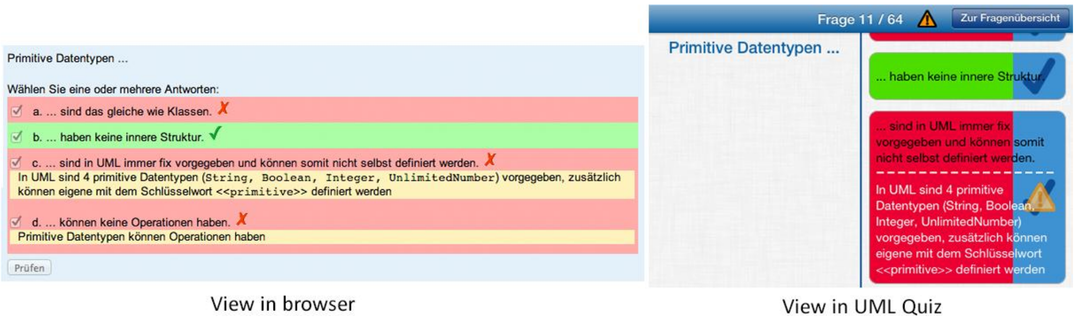

Figure 5. Comparison of solved questions.

UML Quiz offers some additional features that help improve the usability of the system:

- Flashcard system – The application remembers how often each question has been solved and thus allows the user to practice depending on progress.
- Persistent quiz data and progress storage – In the final application, quiz data is loaded on first launch from XML files and then imported in a more convenient format. For access, Apple's persistence framework, Core Data, was used, which uses an SQLite database as underlying storage format. All data from the XML files is stored, and is associated with some new data to track the user's progress. The application remembers how often each question has been answered, which enables the flashcard system to divide up the questions into boxes. Also, the progress of saved, unfinished quizzes is stored. In the application settings, users also have the option to completely reset their progress.
- Multiple language support – The application loads different XML files depending on the device language. Quiz progress is stored independently for each language: whenever a new language is loaded, a new SQLite file will be created. When users switch languages, they are prompted if they want to keep the old language database or switch to the new one.
- Online question updates – It is possible to download new XML files from within the application. It will then parse them and update, add or remove any new content. It is also possible to add new images this way. They are first compared by timestamp, so that files that haven't been changed won't be re-downloaded this way. This feature enables teachers to change questions after the application has been shipped.

4. EVALUATION

UML Quiz was tested by 6 persons[1] from different age groups and with various educational backgrounds. Some were interviewed multiple times during the development process, and some were only shown the final application.

- Multiple iterations of *UML Quiz* were shown to Ulrike (55 years old, college dropout), including the final application. First prototypes of the app were in portrait orientation and had the entire content of a question (question text, answers, images) scroll vertically. Ulrike did not like this interface at all: solving a question was a very tedious process for her, as she had to scroll constantly between the question text and possible answer choices. To fit more content on the screen, a small text size was chosen, which she also criticized, since it was hard for her to read. In the final application, she said that most of the issues had been improved: the landscape layout made it easier for her to solve the questions, as most of the content was visible at the same time, requiring less scrolling. Font sizes were larger and the navigation between questions was much clearer.
- The full application was shown to Micheline (28 years old, non computer science graduate student) after most parts were completed, not having seen the quiz in TUWEL before. She was initially confused with the navigation, not understanding the horizontal swipe gesture to navigate between questions. However, when she had grasped the feature, she stated that she liked it. She was also initially confused by the colors that were used to mark solved questions as correct or incorrect, thinking that the blue check signified correctness, not selection.
- Lukas (23 years old, computer science undergrad student) was shown the full application after most parts were completed. He had seen and used the quiz in TUWEL before, as he participated in the UML course himself. He positively noted the navigation between individual questions and he really liked that one could see all the elements of a question in a single screen. The question overview button at the top left corner of the screen initially confused him, because he wasn't sure where it would lead him. However, when he pressed it and then navigated back to the original question, he understood what had happened. He also stated that he would have used the application, had it been available at the time he took the course.
- Moritz (27 years old, computer science undergrad student) was also a participant in the UML course and had also seen the questions beforehand in TUWEL. He was also shown multiple iterations of the application, including the final result. He did not like the navigation between questions and was especially confused by the button leading to the question overview. The main reason for his dislike was the problem caused by both horizontal and vertical scrolling, as described in the previous section. He positively noted the flashcard system and the online updates.
- Wolfgang (57 years old, non computer science graduate, working as a high school math teacher) is without a strong technological background. He liked the navigational layout and said that it was easy to understand and use. He especially noted the overview screen, allowing to see which questions had been answered correctly after finishing the quiz. However, he thought that the font sizes were sometimes too small and hard for him to read. He liked that the question images were zoomable. He disliked that the answer images are not zoomable, again making it harder for him to read. From his viewpoint as a teacher, he liked that the content could be revised and adapted through online updates, making it easy to add or change questions.
- Marion (instructor of the UML teaching course at Vienna University of Technology) accompanied the entire development process, providing valuable feedback from the perspective of an instructor. She also did not like the initial prototype very much, as the portrait layout made it hard to solve a question without scrolling. She appreciated the switch to landscape mode and suggested further improvements to the layout, which included increasing the font size and removing some UI elements. The initial prototype had an additional UI element to jump from question to question, which was removed in favor of more space for actual content. Marion also liked the idea of splitting drop-down questions into multiple individual single-choice questions, however she was concerned that it might cause confusion for people entering the data in Moodle, who are not familiar with the mobile app.

[1] We thank Marion Scholz for her ideas, support, and supervision during the creation and establishment of the *UML Quiz* and all students who evaluated the system and spent time with us to give their valuable feedback.

These tests have shown that *UML Quiz* improves the usability of the quiz enormously, when compared with the access on a mobile browser on Moodle. The big advantage is that most parts of a question are visible in a single screen and scrolling can be avoided in most cases. Users also reacted very positively to the additional features described in the previous section, especially to the flashcard system. The system generally does a good job in converting the web-based content and making it usable on the mobile screen.

However, *UML Quiz* still has some usability issues, which need to be solved in future work. Most of them are contextual problems caused by the content used in the quiz. Such content has usually been designed with and for desktop screens. An example is the way that *UML Quiz* deals with images. Because most images in the existing data are rather small, *UML Quiz* scales them to the largest size possible with the given screen space, while maintaining aspect ratio. While this works well with most images, it sometimes produces unwanted results, which leads to images like in Figure 6a. In the screenshot, a giant element from a UML diagram is visible, even though the element's actual size is only a few pixels in diameter.

a) b) c) d)

Figure 6. a) Very large images. b) Small unreadable images. c) Long question text. d) keyboard obscuring content.

On the other hand, some images are much too small to read on a mobile device (see Figure 6b). Tapping the image enlarges it to full-screen and enables zooming. However, in full-screen mode it is not possible to see the question text and possible answers at the same time. Thus, users are again required to switch back and forth. In this design, tap-to-zoom could not be provided to enlarge the images displayed as answers, as the action of tapping already selects and de-selects the answer.

Students also complained about still having to scroll too much, which is the consequence of too long question texts or too many answer choices (see Figure 6c). Another problem was caused by both sides of the screen being scrollable vertically, as well as horizontally: Sometimes users try to scroll horizontally to get to the next or previous question, but instead the gesture is recognized as a vertical scroll by the application, and vice versa. This caused a lot of frustration.

Some users criticized the text-box questions because the on-screen keyboard takes up too much space, obscuring the content (see Figure 6d). Confusion was also caused by the problems arising from splitting drop-down questions into multiple-choice questions, as described in the previous section.

Further improvement of the content could solve most of these problems. However, it will likely require manual adjustment of the data. Possible improvements can target data input, as the input mask in the Moodle quiz module is not intended to produce mobile-friendly data.

5. CONCLUSION

In this paper we have shown how a native mobile application can help to improve the preparation for exams at university level. Based on the assumption that "m-learning extensions cannot be developed to an existing e-learning system without changing the pedagogy and design of the learning content" (Hewagamage et al., 2012, p.13), we designed and developed the native mobile app *UML Quiz* and evaluated from different points of view. The results of this evaluation show that it is possible to take existing quiz data from web-based LMS and adapt it for use on mobile devices. Despite the fact that there are several areas for improvement both on conceptual and implementation level, students overall have given very positive feedback to *UML Quiz*.

Further research to improve the content can aim the creation of the content. Another possibility would be a semi-automatic approach to improve the content. Mockups for a new input mask exploring this idea have already been created. The pre-existing content is imported and presented in a live preview in actual size of the mobile screen. It helps the teachers to judge if the content fits the screen and, if necessary, to make adjustments to it (for example, shorten the question text). This approach has received a good response in first evaluations with teachers.

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PEDAGOGICAL APPLICATIONS OF SMARTPHONE INTEGRATION IN TEACHING - LECTURERS', STUDENTS' & PUPILS' PERSPECTIVES

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ABSTRACT

As the disparity between educational standards and reality outside educational institutions is increasing, alternative learning infrastructure such as mobile technologies are becoming more common, and are challenging long held, traditional modes of teaching. Educators' attitudes toward wireless devices are mixed. Wireless devices are perceived by some teachers as a distraction to the educational process while others report the benefits of wireless devices to the learning process. Incorporating mobile technology in teaching can provide a chance for educators to lead innovative pedagogy.

This study was based on an experiment with middle school students, college students and college instructors. The aim of this study was to examine the extent to which the use of smartphones for teaching affects students' motivation. Moreover, it explored students' and instructors' attitudes toward the implementation of smartphones in education: the types of usage they implement and suggest and whether they think that smartphones should be implemented in academia as well as in schools at all.

The study was conducted by a qualitative and quantitative analysis. Relevant information was collected based on the questionnaires, correspondence as well as personal journals and interviews.

There was a difference in the difficulties various groups face. While the middle school students almost did not experience technical problems, the college students and their instructors needed much more technical assistance during the activities.

Middle school 7th grade school students were highly motivated, demonstrated a high level of self-efficacy, found the activities interesting, learned new things and felt that they benefited from the collaborative work. Students expressed willingness to conduct such activities in the future; they said they would recommend such activities to their friends and would be excited to develop an activity of their own.

College students were skeptical regarding the implementation of smartphones in education. Although they could think of various applications of location-based lesson plans, there was no significant difference between the pre-test and the post-test regarding the extent to which they intend to incorporate smartphones in their teaching at school. There was also no significant difference in the extent to which they thought that school teachers should implement smartphones in their lessons and in the extent to which college lecturers should implement smartphones in their lessons.

College instructors were surprised to get acquainted with the "wonders" of technology. They considered the AR as "Hallucinatory" and could appraise the potential of the tool, but felt the need for more training prior to the implementation. They were practical and used the workshop in order to plan projects in the various disciplines that would benefit from the advantages mobile technologies offer.

College students and instructors mentioned the concern that not every student owns a smartphone, and were concerned that students will access improper content on school time.

There is a gap between school students, college students and college instructors in the ease and the extent they use mobile applications. In the transition period it would be useful to act side by side so that teachers can use innovative technologies for the benefit of their students' experience of best practices.

KEYWORDS

Mobile learning, 21st century skills, innovative learning, smartphone uses in education, motivation for learning

1. INTRODUCTION

The disparity between educational standards and reality outside educational institutions is increasing. Alternative learning infrastructures such as mobile technologies are becoming more common, and are challenging traditional modes of teaching. Benefits of mobile learning are numerous and are expressed in different facets of education, including cooperative learning, contextual, constructivist and authentic learning. Mobile-based learning facilitates location-based learning, among other flexible, unconventional teaching strategies. In particular, they offer knowledge-based learning tools allowing learning outside the classroom (Squire & Klopfer, 2007). Furthermore, they enable learners to engage in activities ranging from real-time or lapsed communication and collaboration with colleagues on location-based tasks.

Educators' attitudes toward wireless devices are mixed. There are teachers who report that using them increases the interest and involvement of students, as well as addresses different learning and teaching styles (Lamscheck-Nielsen & Jakobsen, 2009). Wireless devices are perceived by some teachers as a threat to their authority and a distraction to the educational process. To change the perception of mobile devices as a threat, the authors propose to examine the contribution of such technology to teaching and learning. Harnessing the availability of mobile devices and mobile Internet technology for teaching and learning can empower learning anywhere and at any time as well as allow better access to knowledge. This in turn makes learning relevant and adjusted to the information-savvy society in which we live.

Teaching in the 21st century, an era in which the ICT revolution is in full swing, requires teacher and student preparation to educational settings by using relevant, meaningful and challenging teaching methods, and by leading innovative pedagogy. In a reality whereby students own multimedia and personal communication devices, and are constantly acquiring new skills of information sharing and communication (Sharples et al. 2007), traditional classroom models where exams are held, content and dialogue is dictated by the curriculum and managed by the teacher do not fit in easily. These two worlds come into conflict when children bring mobile devices. Rather than focusing on the threat of mobile technologies to formal teaching, technological changes can be regarded as a positive challenge to schools, and a means of bringing teaching into the mobile technology age. Proper harnessing of the technological means available may facilitate flexible learning, that is, learning without the boundaries of time and place, characteristics that are increasingly in demand in the 21st century.

2. THEORETICAL BACKGROUND

2.1 21st Century Skills in the School Context

As a result of the accelerated technological development that transpires all around us in the digital age, we are required to adapt to frequent changes in our environment. The majority of teaching staff in teacher education programs was not born into the digital-informational revolution, and so must undergo training themselves to prepare for digital proficiency. This generation of technology users has been called "Generation X", or "digital immigrants", and it is they who will educate Generation Y – the generation born into the information age (Prensky, 2009) and the ones who will educate and teach the "Z Generation". The education system must therefore modify its teaching methods for the oncoming wave of digitally-proficient students, their skills, experiences and needs.

Teaching in the present era calls for reference to technological transformations as well as attention to definition of school, teachers, learners and curriculum. For the increased incorporation of technologies, Daggett (2005) argues that a shift in focus is necessary, from teacher-centered instruction to student-centered learning in which teachers take a secondary position as director, guide and supporter of the learning process. They believe that this is the only way for developing learners' leadership skills, teamwork and necessary and relevant skills which will assist them to cope with challenging daily issues. According to Daggett, this will help students develop leadership skills, teamwork and other competences necessary and relevant to challenging issues in everyday life and the needs of the future workforce. Additional skills required are creativity and ingenuity, communication and collaboration, critical thinking and problem solving (Salpeter, 2003). Training programs that take into consideration technological changes must be committed to address the reform needed in teaching methods and take advantage of the potential of mobile technologies for an innovative pedagogy in education.

2.2 From Traditional to Innovative Pedagogy

The innovative pedagogy focuses on the transition from teaching to knowledge building and changes the power foci of teachers and learners, of the learning activity and of the role of technology. According to the model conceived by Shulman (1986), "teachers' knowledge" cannot be defined without the relation between the area of knowledge content and pedagogy. Teachers are expected to acquire the required unique knowledge which will allow them to teach in a unique way various content areas by means of technology. Moreover, they can choose appropriately between learning contents, technological means and pedagogical aspect (TPACK – Technological Pedagogical and Content Knowledge) so that they make an informed pedagogical use of technologies (Koehler & Mishra, 2005). Salomon (2009) claims that the assumption that the very introduction of computers or any other peripheral equipment will change school and its teaching method was proven wrong. It is easy to acquire equipment but difficult to lead a cultural-systemic change. According to Salomon, the introduction of technology was not accompanied by a meaningful pedagogical change in the school culture, definition of teachers' role and work methods. Indeed, although new technologies evoke varied opportunities for innovative, proactive and effective learning, in practice teaching duplicates the traditional teaching and does not exploit the possibilities offered by the technology (Conole & Culver, 2010). Conole & Culver maintain that this stems from the fact that teachers are unaware of the potential embodied in the new technologies and lack competences to design learning activities which effectively make use of the technology.

Educators need to think about adapting teaching methods to the changing world, whereby IT activities are currently integrated in teaching. Puentedura (2006) suggests a SAMR framework for characterizing the level of technology-integrated teaching. This model consists of four levels: (1) Substitution – at this level technology is used for replacing older tools; (2) Augmentation – this level is close to the first level of use with additional functions; (3) Modification – at this level technology is used more effectively. Parts of the task are re-designed, thus modifying the learning method; (4) Redefinition – this level is parallel to the high levels of thinking – synthesis and assessment – leading to teaching and learning models which are different from those not using technology.

As with the integration of any technology, integrating smartphones in teaching raises concerns regarding the exploitation of technology capabilities and effective ways of integrating education technology. Carrington's wheel of pedagogy (Carington, 2012) maps the various applications according to the levels of thinking they encourage. The wheel of pedagogy can aid teachers in the process of development, characterization and outlining available applications in order to promote higher-order thinking skills and to effectively leverage technology for learning.

2.3 Mobile Technologies, Teaching and Motivation for Learning

Smart mobile devices allow the collecting, organizing, storing and presenting of information. They are equipped with advanced multimedia players, provide access to recently updated information, store contacts and allow for real time communication using a wide range of Internet environments. They also provide the possibility to synchronize information regularly and access it anywhere, any time.

Many cellular tools and applications that are being developed; are not intended specifically for educational purposes, but can nevertheless be used in the process of teaching and learning. One example of this is the QR Code generator. Another example is augmented reality digital information, known as “AR”. Through AR, learners are able to gain immediate access to a wide range of location-based information, compiled and provided by a variety of sources. Students can be engaged and motivated to explore class materials from different angles (Kerawalla, Luckin, Selijefot, & Woolard, 2006) and gain real-world first-hand experience in subjects that were not feasible otherwise (Shelton & Hedley, 2002). These technologies bridge the gap between physical content, since they allow access to digital content based on printed materials (Johnson & Adams 2011). These features of mobile technology require attention from educators in order to harness these resources to teaching and to formulate and adopt an updated pedagogy.

When considering the use of mobile technologies in education, one promising aspect is student motivation. Learning by means of these technologies is often perceived by students as informal, enjoyable and motivational, even if the use does not involve interactive games. Fundamentally informal learning emphasizes learners' goals and interests rather than learning goals, and therefore has the effect of strengthening learners' internal motivation (Sharples, 2007). Students engaging in mobile learning report that this gives them a sense of heightened control, ownership, fun, allows enhanced communication and enables learning in context (Jones et al., 2007; Sharples, 2007).

Mobile technologies offer many options that can be useful in teaching. Laurillard (2007) suggests creating learning activities that take advantage of the uniqueness of the technology. These technologies offer discovery and study of physical environments, maintaining synchronous and a-synchronous dialogue with colleagues. Mobile technologies also offer many options of information capture, access and manipulation. Enhanced feedback is also possible, as mobile platform allows for the tracking of processes.

In this context, Laurillard suggests adopting a pedagogy that both promotes quality learning and is more sustainable and flexible than traditional teaching methods. It is crucial to try understanding the type of exercises required for learning complex concepts and higher-order thinking skills, and develop pedagogical applications that produce the desired learning results. Like Laurillard, Sharples (2007) also claims that in order to develop innovative educational activities, it is necessary to integrate technology and learning in a manner whereby pedagogy and learning theories are the driving forces, rather than the technology. Naismith & Corlett (2006) also provide a review of technologically-oriented pedagogies. They suggest taking advantage of the unique technology affordances that can contribute to an enhanced user experience. Planning and design of learning activities must be specific and goal-driven. At the same time, the planner must take into consideration the added value of mobile technologies, to allow for teaching in the best possible way using the chosen teaching tool.

2.4 Pedagogical Uses of Advanced Mobile Devices

Wireless devices serve as a “compass” for finding new information (Vandi & Djebbari, 2011) and enable access to location-based information on the basis of interest and personal need (Hicks & Sinkinson, 2011). Among the advantages of mobile learning are the ability to design cooperative, contextual, constructivist and authentic learning. This type of learning integrates mobile learning and flexible teaching strategies.

Mobile devices can be used to investigate new content by turning passive data sources that contain huge amounts of information into interactive objects (Vandi & Djebbari, 2011). This makes learning more relevant, allowing learners to access information at the right time and place. Providing the opportunity to interact with the learning materials enables a kinesthetic learning approach. Mobile resources can be an ideal way to provide immediate assistance to students through the devices they own and use themselves, to provide background on what is learned and enable individually-paced learning (Chen, Teng, Lee & Kinskuk, 2011). The aim is for students to efficiently and effectively use mobile devices to enrich the learning experience (Fasimpaur, 2011). In addition, orientation-enabled mobile devices have an advantage in reducing memory load, real-time support satisfaction and facilitate classroom management processes.

Embracing these technologies that are broadly regarded as a nuisance, if used correctly, is certainly more constructive than the attempts to fight and resist technology in the classroom.

In conclusion, mobile phones and mobile applications offer a wide range of opportunities to educators and learners as well as the community by preparing its members for the wide range of subjects and skills necessary for the 21st century. The ubiquity of mobile devices today along with the empowering potential of these devices makes mobile technologies a great candidate for integration in learning, and useful for the skills needed for employment in the future. While it is clear what educators and pedagogues think of mobile integration in the classroom, students' opinions are still underexplored. The aim of this study was to examine the extent to which the use of smartphones for teaching affects students' motivation as well as students and instructors' attitudes toward the implementation of smartphones in education: the types of usage they implement and suggest and whether they think that smartphones should be implemented in academia as well as in schools at all.

3. METHODOLOGY

3.1 Participants

This study was based on an experiment with middle school students, college students and college instructors. The student group consisted of 32 seventh grade students who used their smartphones for learning a location-based activities unit regarding Australia. In addition, another two groups of 59 eighth grade students who learned a science unit using augmented reality smartphone technology and their counterpart group which consisted of 57 eighth grade students who learned the unit in a traditional manner participated in this study. The college group comprised 42 students studying towards a Master of Education degree in teaching combined with a teaching diploma. The average age of the students was 32 years. They were from various disciplines associated with the subjects taught in Israeli high schools, such as sciences, arts, history, and literature. The group of college instructors consisted of 18 members, average age 52. The instructors were from science discipline, math, computer education and art.

3.2 The Activities Implemented

School students - The seventh grade students completed an eight-hour unit, of which the smartphone-based activity comprised a two-hour lesson during which they expanded the vocabulary and enhanced their reading comprehension. They read stories about bears, koalas and marsupials. They then used their smartphones in groups of three students, along 10-station activities, relying on the information acquired during the previous lessons and discovering new knowledge. The workgroup allowed the students without a device to participate in the activity. In addition to the seventh grade students, four eighth grade student groups (116 students) participated in the study (Tshuva-Albo & Seifert, 2013). Fifty-seven participants (two classes) formed the experiment group and 59 prticipants (two groups) were the control group. The eighth grade students studied a science unit on interaction, using augmented reality through their own smartphones. Using their own smartphones enabled them to bypass the fact that they had no computers available at school. The activity included watching animations, videos clips, pictures, listening to podcasts and conducting collaborative activities in Google Docs and sharing them through their smartphones.

College students - The college students participated in a mandatory course on innovative technologies in education throughout a period of one academic semester. Two students conducted their smartphone-based activity with their peers during a 90-minute period. Class was divided into 9 groups of 4-5 to complete several sub-activities. Following the activity and based on the pedagogical models they were exposed to along the course, students were required to design an activity using smartphones efficiently.

College instructors - The college instructors participated in a 4-hour workshop in which they were instructed on mobile technology affordances. During the workshop, the lecturers came up with ways to implement various applications of mobile technologies in their teaching.

3.3 Instruments

Data presented in this study regarding the middle school and college students was collected before the activity through a pre- and a post-questionnaire. The eighth grade groups were compared based on an existing questionnaire (Midgley et al., 2000) on motivational components: level of interest and the perception of self-efficacy.

In addition, during the lesson immediately following the activity, a forum was assembled in which college students reflected on application of smartphone in their various disciplines, wrote their suggested lesson plans for their students and any comment they had. The questions focused on students' attitude toward implementation of smartphones in education and its contribution to learning.

College students were also asked whether they would implement it in their classrooms and whether they think that their instructors should implement smartphones in teaching. In addition, throughout their course, college students reflected on their work in a personal blog, where they described the process of lesson planning, and shared their work and thoughts with their peers and teachers. The instructors filled in a short questionnaire prior to the workshop and at the end of it.

The study was conducted by a qualitative and quantitative analysis. Relevant information was collected based on the questionnaires, correspondence, course forum and personal journals and interviews.

3.4 Findings

Among the 32 middle school students, 78% owned a smartphone and 22% did not. Among the college students who filled in the questionnaire (37), 74% owned a smartphone and 26% did not. Among the 18 instructors, 78% owned a smartphone and 22% did not. There was a difference in the difficulties various groups face. While the middle school students almost did not experience technical problems, the college students and their instructors needed much more technical assistance during the activities.

Middle school 7th grade school students found the activity interesting (M=4.0) on a range of 1-5. They learned new things (M=3.5) and they felt that they benefited from the collaborative work (M=3.8). Students expressed willingness to conduct such activities in the future (M=3.5); they said they would recommend such activities to their friends (M=3.5) and would be excited to develop an activity of their own (M=3.8).

Eighth grade students who experienced AR technology were found to be highly motivated compared to the control group: an average level of interest of (M = 4.4) compared to the control group (M = 3.7) and was found significant ($P < 0.05$, $t(114) = 4.9$). As for the perception of self-efficacy, the average rate of the experiment group who experienced AR was higher (M = 4.39) than the average of the control group (M = 3.78) and was found significant ($P < 0.05$, $t(114) = 4.6$).

School students think that smartphones could assist them in their learning. one student stated that when using his smartphone it helps him to concentrate and enables him to learn more.

College students were skeptical regarding the implementation of smartphones in Education. There was no significant difference between the pre-test and the post-test regarding the extent to which college students intend to incorporate smartphones in their teaching at school. There was also no significant difference in the extent to which they thought that school teachers should implement smartphones in their lessons and in the extent to which college lecturers should implement smartphones in their lessons.

In general, the mere exposure to the smartphones and the personal experience brought the students to consolidate their attitudes toward the subject and to think about appropriate ways to integrate smartphones in teaching. In addition to the quantitative findings, students expressed their opinions in the open-ended questions and in the forum and blog. Students' responses included a number of aspects: strong opposition for classroom use and adherence to traditional teaching methods, ambivalence while raising objections and suggestions for implementing controlled use of smartphones as part of planned process. Some students favored the usage as raising motivation and as part of the ideology of no prohibition of the usage of smartphones in class. Others favored the implementation only after setting clear instructional goals. Some students changed their opinion after they experienced location-based activity. Based on the pedagogical models they acquired during the course, some students were able to design activities that promoted higher-order thinking skills and were able to use smartphones effectively.

College instructors were surprised to get acquainted with the "wonders" of technology. They considered the AR as "Hallucinatory" and could appraise the potential of the tool, but felt the need for more training prior to the implementation.

We found a difference in the way the three generations relate to smartphones and mobile technology: Middle school students use their smartphones to download and listen to music, Facebook, download applications and contact friends and family. If mobiles were allowed in class, students stated they would use them for translation, recording, taking notes, taking pictures of the board instead of copying the material, use the internet to clarify issues and expand knowledge, calculator, text to voice software and spellchecking. In the post-test they suggested using their smartphones in order to take exams, view maps in geography, learn history facts and solve math riddles. Some students felt that using the various functions smartphones offered could save a lot of time in the classroom. College students, on the other hand, use smartphones for surfing the Internet, as a GPS, learning management, Facebook, recording lessons, chat, watch alarm and taking notes. Most instructors use smartphones for making calls, time management, mind maps, keeping a calendar, and very few other applications, which they discover gradually.

Middle school students found the activity interesting (M=4.0), learned new things (M=3.4) and benefitted from the collaborative work. Participating students enjoyed the activity (M=3.0, SD=1.1). For most of the students, this activity was different from the usual types of lessons they have experienced. They learned an innovative topic and had to participate in an activity designed by two of their peers. The students who designed the activity received guidance during a 6-week preparation phase. Following the activity, students presented their ideas regarding smartphone incorporation in class in their various disciplines giving ideas in fields such as: History, Literature, Biology, Physics, and Communications to name but a few. There was no significant difference between the pre-test and the post-test regarding the extent to which students intend to incorporate smartphones in their teaching at school. Students mentioned the concern that not every student owns a smartphone, and were concerned that students will access improper content on school time.

College instructors were practical and used the workshop in order to plan projects that would benefit from the advantages mobile technologies offer. For both teachers and students, participation in smartphone-based activities was eye-opening: it was more of an experiential teaching experience than any lecture could be. After the activity, students were less skeptical about the potential of smartphones in education.

Further examples of activities of location-based learning implemented by the students and instructors and further findings will be presented in the lecture.

4. CONCLUSION

Despite the benefits of having students bring their own devices, it is necessary to deal with the variability and the wide variety of types of devices which students possess and find means to deal with technical difficulties.

Middle school students were very excited about the prospect of incorporating cell phones and AR into their learning. Incorporating smartphones and AR can increase the elements of interest rate and provide students with a learning space in which they can act and research different topics, having the teacher spark their imagination and guide them along the process. Designing the learning environment in a way that harnesses the potential of available technologies and engages the learners can promote a number of factors such as the level of motivation: pleasure, curiosity, access to information, interactivity, diversity and address learning differences. From the teachers' perspective, preparing the units was an innovative and intriguing experience which propelled them on a professional level as professional teachers in the 21st century.

College students, on the other hands, were very reluctant to implement smartphones in their classrooms. One reason that college students' attitudes did not markedly change after the activity could be that students who participated in this study are still in training. When they begin teaching in schools, they will first need to make sure they can establish themselves respectably in their new setting. Only then will they be ready to lead new changes. Once teachers experience the implementation of an activity with mobiles and overcome technology difficulties, they start considering interdisciplinary activities such as an activity combining English and history, exposing students to art, music, architecture and, thus, gaining reading comprehension, grammar and vocabulary. Another reason for the students' lack of perspective shift may be that the activity in which they participated wasn't directly related to their area of expertise and they did not experience the integration of the activity they designed in a school setting. Because of this its impact on them was not as effective as it could have been. The process was also short, so the opportunity for a profound reversal of student opinions was limited. Yet another reason is cultural: the Israel Ministry of Education does not regard implementation of the technology positively. Most current educators are also not very receptive to the changes that come with new technologies.

College instructors were ambivalent about integration of mobile technologies in their teaching. They were not aware of the potential the technologies offer, but needed more exposure to the value of technology and time to become adept at using mobile technologies before being ready to incorporate them into their teaching. Massive personal training in using applications that are related to their expertise and giving them extra value to their teaching can encourage them.

Qualitative findings reinforce the importance of integrating mobile technologies in teaching and learning, as part of the pre-service training programs. Practice in these areas enables students to acquire skills and experience, develop attitudes towards the usage of mobile technology, and make decisions regarding best ways to exploit technology for pedagogical needs.

There is a gap between school students, college students and college instructors and in the transition period it is beneficial to act side by side. One solution for instructors can be harnessing the technological abilities of students: teachers can ask assistance from a small group of students in using the technologies with which they are so familiar, thus empowering the students and acquiring the help they need. Teacher education programs must tackle the difficulties and the generation gap and train students and college instructors accordingly.

This study sheds some light on the questions that each new technology raises during its first implementation stages. As students stated, it is important for teachers to know the affordances and benefits of this technology, as well as to be aware of the difficulties that are part of the process of implementation of a new technology. Through slow, gradual introduction of the technology into the classroom, teachers can gain pedagogical experience without being overwhelmed.

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MOOC TO GO

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ABSTRACT

Massive Open Online Courses (MOOCs) have been one of the major trend topics of the last years within the e-learning community. Many companies, such as Coursera, edX and Udacity, launched MOOCs offering a broad range of topics. In this paper, the authors will take a look at the mobile support of different MOOC providers. Use cases and benefits of mobile access to a MOOC platform—both online and offline—will be shown. Finally, openSAP's solution to address this task will be demonstrated.
In this context, key technical decisions, which can serve as a blueprint for other MOOC providers will be discussed.

KEYWORDS

MOOC, Mobile Learning, Ubiquitous Learning, Responsive Web, Learning Apps

1. INTRODUCTION

Massive Open Online Courses (MOOCs) have been in the focus of the worldwide e-learning Community since at latest in early 2012, when Sebastian Thrun founded Udacity, based on the success of the experiences he made in 2011 at Stanford University offering a course to 160,000 students. Other players like Cousera and edX followed soon within the very same year. Soon, millions of users worldwide joined one or more of these free courses.

While much money and manpower was invested to build these platforms, the business models behind these new founded companies and organizations have been subject to frequent changes, as Schulmeister (2013) has been shown. In a type of a gold-rush mood the MOOC Providers battled to be first to market.

Despite the amount of scientific research on Mobile and Ubiquitous Learning when these companies launched their first courses, the impact of this research on the MOOC providers was minimal, as the authors will discuss in section two. While there have been MOOCs dealing with the topic of mobile learning, as described by de Waard (2011a), mobile technology as a part of the learning experience hasn't been in the focus of these MOOC providers.

The authors will discuss the demand and supply of mobile solutions for MOOCs in general in section two, while section three will focus on the current development of a mobile app at openSAP. Finally, section four and five will show limitations and problems, and highlight topics for future research.

2. MOOCS IN THE CONTEXT OF UBIQUITIOS LEARNING

2.1 Comparison of Mobile Device Support on Major MOOC Platforms

Following Hwang (2008) ubiquitous learning can be defined as "learning anywhere and anytime." Mobile learning therefore can be considered as a subpart of ubiquitous learning that includes mobile devices and wireless communication. In section two we will discuss the mobile support of selected MOOC platforms and take a look at the offline and slow bandwidth usage.

Mobile and Ubiquitous Learning (MUL) has been a trend topic long before MOOC became one of the hot topics in e-learning, as shown by Hwang and Tsai (2011). However, when the first MOOCs became available all platforms of the major MOOC providers lacked a proper support of MUL. As de Waard (2011b) states, based on a survey of the participants of the MobiMOOC (a MOOC focusing on mobile learning and provided through a Wiki and an accompanying Google Group), 55% of the survey participants answered that they think that it is possible to follow a MOOC entirely through mobile devices.

Despite that fact, at the time of writing, none of the other major MOOC platforms offered a dedicated mobile app or website. However, research in the social media channels of Udacity, Coursera, and edX has shown that all of these platforms at least have unofficially confirmed that they have plans to offer better support for mobile devices.

It is not very astounding that My Open Courses [1], an Indian MOOC provider and official partner of the government programs NMEICT [2] and NPTEL [3], is a step ahead in delivering its contents via mobile devices as mobile technology has been leapfrogging the distribution of PCs and laptops in developing countries [4].

Table 1. Mobile Support of major MOOC providers, last updated at 11/25/2013

	edX	Coursera	Udacity	iversity
URL	edx.org	coursera.org	udacity.org	iversity.org
Responsive Website	Yes, min. 1024px width	No	Yes, min. 800px width	Yes
Own Mobile App	No	No	No	No
Mobile App planned	Yes	Yes	Yes	-
Third party solutions	iOS	iOS & Android	-	Android

The evaluation of the MOOC providers' mobile support in table 1 is based on statements in their social media channels, in-platform forums, and FAQ's. edX states on Facebook "[...] At this time, we do not have full support for tablet or mobile browsers. (We're working on this!) [...]" (edX Facebook (2013))

Questions on mobile support in Udacity's discussion forum are answered rather vaguely: "For the moment we don't support mobile platforms such as Android or the iPad. We are working on having support for them, however I don't have an ETA for when it will happen."(Udacity (2013)) An article about a new round of funding for Coursera in Forbes Online states, "Coursera has started building up a mobile devices team." (Forbes (2013a))

Third party apps are available for most of the platforms (see Table 1), demonstrating the users' demand for mobile solutions.

2.2 The Demand for Mobile Solutions for Ubiquitous Learning

On openSAP, an enterprise MOOC portal described in section three, a special type of a discussion forum[5] is presented to the users at the end of each course. It animates the users to articulate their praise and critique for the current course and their wishes for future courses. The following statement represents a wish that has been articulated by many users:

"I wish there would be stronger support for mobile devices: [...] Better touch friendly navigation for mobile devices. [...] I wish openSAP would re-consider a use case for mobile consumers: [...] I'd prefer a dedicated openSAP app to deliver a more usable, fluid user experience [...]"(openSAP Forum (2013))

The most common motivation for these wishes is the, currently missing, possibility to attend the courses offline on the commute. Another use case is demonstrated by the following discussion-post on openHPI: "Dear openHPI-Team, I'm currently in Spain and follow the lectures in a beach bar via a hotspot; I've got my iPad but no laptop with me [...]" (openHPI Forum (2013))

Often, participants cannot complete a course because they have left for holidays during the time of the course's final phase.

Identifying the need for MUL from analytics tools, such as Piwik [6], is difficult. These tools detect mobile devices based on the device information, which is retrieved from the requesting browser. This artificially

[1] http://myopencourses.com/
[2] National Mission on Education through ICT (http://www.nmeict.iitkgp.ernet.in/signalmain.htm)
[3] National Program on Technology Enhanced Learning (http://nptel.iitm.ac.in/)
[4] see e.g.: http://www.economist.com/node/10650775
[5] The I like, I wish format is a method, which originates from the Design Thinking process (http://dschool.stanford.edu/wp-content/themes/dschool/method- cards/i-like-i-wish-what-if.pdf)
[6] http://www.piwik.org

simplifies the complexity of the user scenarios to be expected in a MOOC learning environment. The used device is only one of the aspects that should be considered.

Table two shows that another important aspect is the availability of high speed Internet, providing enough bandwidth (on reasonable conditions).

Table 2. MOOC-Usage scenarios based on device and Internet connectivity

	Broadband	Slow Internet	No Internet
Mobile Device (Tablet)	Responsive Solution	Dedicated app to watch videos that have been downloaded earlier (At a point of time when the internet connection was faster, e.g. at home while connected via WLAN vs. on the commute while connected via UMTS). Textual content can be accessed. Quizzes and homework assignments can be submitted.	Dedicated app to watch videos that have been downloaded earlier. Quizzes and homework assignments cannot be submitted (Optionally, they could be stored on the mobile device and synchronized when a connection has been established again. Currently the authors are reluctant to add such a feature due to the complexity of the resulting issues).
Notebook or Desktop	Normal Website	Videos can only be watched if previously downloaded. Quizzes and homework assignments can be submitted. Participation in the discussion forum is possible.	Videos can only be watched if previously downloaded. No other form of participation is possible.

Research in openSAP's user tracking tool showed that, currently, mobile devices hold a share of 8 % of the visits and 5 % off all actions, such as page views. The iPad holds a share of 29.6 % of those visits. This number does not appear to be essential, but there are a couple of aspects that have to be considered:

• The number does not include those users who download the teaching videos on their desktop computer to watch them later on their mobile devices.

• Even on a web application that explicitly does not provide an optimized solution for mobile devices, one out of twelve visits comes from a mobile device (Higher numbers might be expected after providing a fully responsive version).

3. MOBILE SUPPORT AT OPENSAP

SAP, one of the world's largest software companies (see Forbes (2013b)), was one of the first global enterprises that launched its own MOOC portal: openSAP[7] offers free MOOCs to an interested audience. openSAP is a partner platform of openHPI (see Meinel & Willems (2013)), which delivers MOOCs since September 2012. The Hasso-Plattner-Institute at the University of Potsdam, Germany, provides openSAP with scientific guidance.

openSAP started in June 2013 with the course "Introduction to Software Development on SAP HANA." In November 2013 (the time of writing), 77,679 registered users enrolled 134,648 times in a total of 5 courses. 41,411 of these enrolled users can be considered as active participants (See Willems *et al.* (2013)) for the definition of active users at openHPI and openSAP). Two of these courses had been concluded at the time of writing. In these courses, a total of 14,810 Records of Achievement (RoA) and 17,817 Confirmations of Participation (CoP) have been issued to the course participants.

Courses on openSAP follow a traditional MOOC concept, so they have a defined start and end date and are structured into weeks. Each week consists of short video lectures, followed by diagnostic e-assessments (self-tests).

Currently, the openSAP website provides only limited support for tablet devices and is not optimized to be used on smartphones. To better support mobile devices—both online and offline—openSAP decided to create a native app, which is shown in Fig. 1. Currently, only iPads—running iOS 6 or higher—are supported. Smartphones and tablets running a different operating system are not supported by now. Table

[7] https://open.sap.com/

three shows a list of all major functionalities and their availability in respect to the available Internet connectivity, which are covered by the first release of the openSAP app. It is implemented as a hybrid app as described in Willnecker *et al.* (2012).

Thus, it features a mix of native views, which access the openSAP platform's data through a provided API, and web views, which load the platform's HTML pages into an embedded browser component.

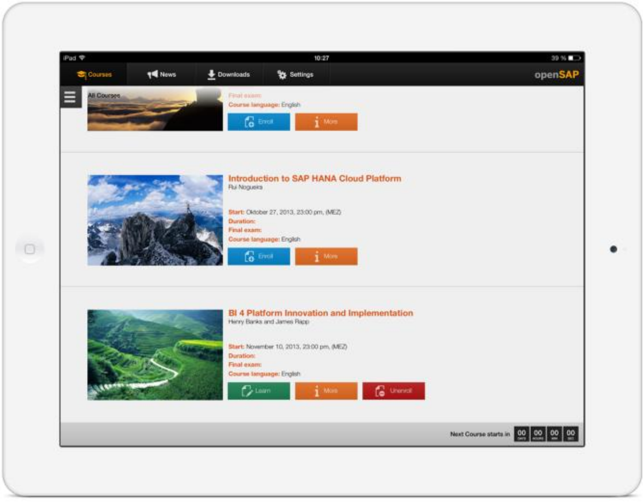

Figure 1. The app with the native course list for

Table 3. Offline availability of functionalities in the openSAP app

Function	Offline	Online
Register on platform	No	Yes
Enroll to course	No	Yes
Browse courses	Yes	Yes
Watch a video	Yes, if downloaded	Yes
Take a quiz	No	Yes

3.1 Optimizing API-Requests

The API was developed following the principles of the REST architecture as described in Masse (2011). The API Design is coherent to the usage of entities within the mobile app and does not rely on implementation details within the current platform.

The app can access the following content through the API:

- Courses, sections and items (items include videos, content pages and quiz pages)
- Announcements (such as global and course specific news)
- Enrollments (the courses of a specific user)
- Progress (the learners progress and visited items)

Following a strict REST design approach may lead to complex sequences of API calls for, otherwise, rather simple use cases. For example, the workflow to get a user's course progress would look like:

- Get the sections of a course
- (For every section) get all the items
- (For every item) get the progress of that item

This would result in many HTTP-requests from the app to the API-server, a large HTTP and data overhead, and therefore, a significant slower app performance.

To solve this problem, two solutions have been discussed. One possibility is to keep the API design strict to the REST paradigm and introduce a middleware layer, to cache requests and optimize access for the app.

As this solution results in higher maintenance efforts, the REST paradigm was softened where it appeared to be reasonable. It was decided to provide API Calls that enable access to the data in a more convenient way. In the given example this results in a single API call. Thereby, loading times within the affected parts of the app have been reduced from a few seconds to parts of a second.

3.2 Optimized Views

To improve the maintainability and reduce the required amount of effort for the implementation of the app, so-called web-views were used whenever it appeared to be reasonable. These web-views are loading certain HTML-pages from the platform into an embedded browser view component. Some parts of the loaded HTML pages have to be adjusted for the usage within the mobile app to provide an optimal user experience. For example, the header of the course page needs to be hidden, as the mobile app provides a header of its own. Furthermore, certain buttons to trigger functionalities—which either are not offered or handled differently in the context of the app—had to be hidden as well.

A first approach to handle this problem was to process these adjustments on the mobile device. The app code downloads the HTML, parses it, and modifies it as needed. This approach requires the app to be aware of the structure of the downloaded HTML.

Let us examine the following example. Assumed we have the following header:

```
<div id="header" class="no-print␣no-user">
  <img id="topbg" src="/plugins/.../bg.png" class="w100" height="106" alt="">[...]
  <a href="/login">Login</a></li> </div> [...]
 </div>
```

The app could either remove the HTML node with the id 'header' or inject custom CSS to hide that node. This approach introduces a severe maintainability issue, however. Assumed the website receives a facelift or gets updated to use HTML5 as in the listing below:

```
<header><img id="topbg" src="...bg.png" class="w100" height="106" alt="">
<div id="header-inner" class="main">[...] <a href="/login">Login</a></li>[...] </div>
</header>
```

This update of the website would break this feature of the mobile app (until an update of the app), as now the header cannot be detected and hidden or removed anymore.

Another approach that has been discussed was to add classes that serve this specific purpose to the page's HTML code. The app could now inject CSS to target these classes.

```
<div id="header" class="no-print␣no-user␣hide-me-in-ipad-app">
 [...]
</div>
```

This approach seems more feasible in terms of maintainability; still, yet another scenario needs to be reflected. The possibility that future development requires additional HTML elements, which will only be delivered to views that are requested from within the context of the mobile app, is reasonably high. Also, different versions of the app might require different versions of HTML to be delivered. Therefore, it was decided that the app should send a customized HTTP header with each HTTP request.

```
Example : User−Platform : OS APPIDENTIFIER APPVERSION
          User−Platform : iOS open.sap.com 1.0
```

Figure 2. The app with the native course list for

This header will be recognized by the platform, which in return will deliver the customized views to be displayed in the mobile app's web-views. Thus, the bigger part of the maintenance has been moved from the mobile client to the server, where it can be handled much easier and does not require the user to download a new version of the mobile app whenever the code on the platform has been updated (see section 3.3).

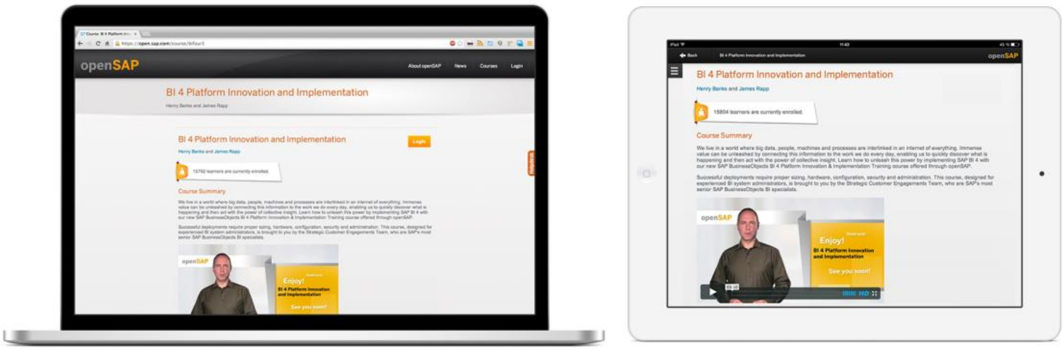

Figure 3. The course view in the platform and within the mobile app

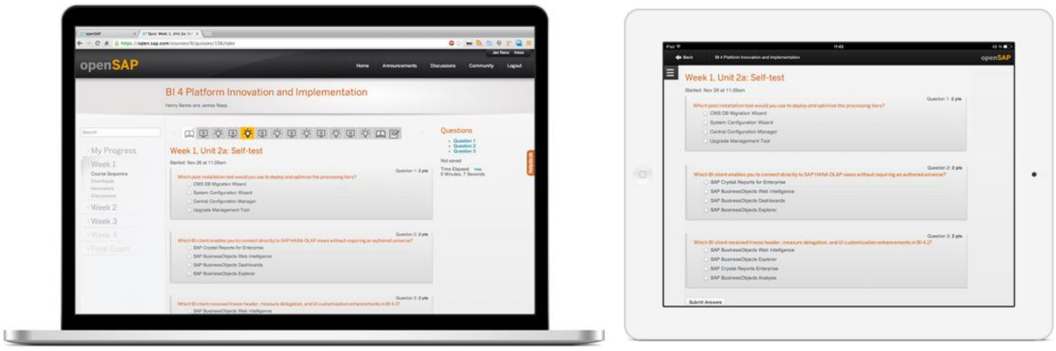

Figure 4. The quiz view in the platform and within the mobile app

As shown in Fig 3 and in Fig 4 an adapted web-view might omit some elements of the original web page. In this specific example the header(s), the left-hand navigation, and the login and help-desk buttons have been removed from the web-view, as these functionalities are natively provided by the mobile app.

3.3 Update and Release Cycles of the Mobile App

In web development, there is a trend towards continuous integration and rapid deployment cycles as described in Fowler & Foemmel (2006). After an update of the web platform all users will automatically access the newest version. In comparison to the easy rollout of a new version of the openSAP platform, updating the openSAP app is a more complex and time-consuming procedure. After creating and testing a new build of the app, it must be submitted to Apple. Only after a successful review by Apple it will be distributed to the user through Apple's App Store [8]. Even if a new version of the app is finally rolled out to the app store, there is no guarantee that all users will update to the new version. Especially those who disabled the automatic update function within iOS might stick with older versions of the app. This will lead to fragmentation and higher complexity in maintenance and user support.

3.4 Public API Specs to Encourage Third party Apps

Given the target audience of openSAP, which includes developers and other people interested in SAP's technologies, it can be assumed that many of the course participants have a high level of technical knowledge. By publishing the API documentation to the public, everyone would have the chance to use the API to send and retrieve data from openSAP within her own tool or environment.

This would enable users and third party developers to create their own native apps, as an alternative to existing ones or for currently unsupported platforms. Apps could be tailored to their own needs (e.g. an XBMC 8 Plugin showing all videos from the courses in which the user is enrolled). Shifting app development

[8] https://itunes.apple.com/de/genre/ios/id36

from the MOOC creators to 3rd party developers may lead to a faster release of apps, as limited resources of MOOC creators can be bypassed. As openSAP decides, which data will be published, and this decision by design reflects the user's access level, security and privacy issues are no concern.

There is a serious risk for the brand image, however. Badly designed, broken, or unmaintained 3rd party apps could reflect negatively on open Sap's public perception and image. Therefore, a strategy to deal with a possibly unsatisfying user experience of 3rd party apps is a core requirement before steps in this direction can be taken.

4. CONCLUSION

As shown in this paper, the support for MUL within the MOOC context needs to be improved. Although the users request native apps, they are not highest priority for MOOC providers today. MOOC platforms are new, and many other tasks with higher priority seem to be on the MOOC providers' agenda. Thus, currently, there are only very rare offerings of mobile apps by MOOC providers as they leave 3rd party providers to fill the gap. Owed to the tight time-boxing of MOOCs with fixed start and end dates, weekly deadlines, and the important role of the social context (see Grünewald *et al.* (2013)), users demand access to the platform on a regular basis, no matter where they are or what type of devices they can access. Mobile apps, such as the openSAP app, can provide the users with this possibility and, therefore, provide a ubiquitous learning experience.

Native apps are not necessarily required anymore to access MOOCs that adhere to the principles of responsive design. However, they can offer functionalities that cannot be provided within the browser environments today (for example downloading videos to watch them later offline at some point in the future). The openSAP app shows how the advantages of reusing components such as responsive web-views can be combined with native functionalities to find a balance between maintainability, costs, and user experience. Only native apps (including hybrid ones) allow a seamless usage in situations where a sufficient broadband connection may not be available (e.g. triggered by a change of the user's location).

To provide a ubiquitous user experience and to satisfy the users' requests, it is required to fill the offline gap in a mobile learners MOOC usage. The openSAP app addresses important parts of this gap (primarily the offline access to the videos). However, not all use-cases of taking a MOOC can be offered on mobile devices and even without a broadband connection (see table three). This may be resulting from technical issues (lab environment cannot be started on tablets hardware), the required amount of work to port server side components to the client (like quiz environments), or components that cannot be cached and provided offline (like communication and discussion tools). To address these issues, further development and research is required to bring MOOCs and MUL even closer together.

5. FUTURE RESEARCH

5.1 Ubiquitous Learning Based on HTML5 Features

The current approach of a hybrid app has several disadvantages. One of the biggest is the support of only a single platform. Minimizing the native part and shifting functionality to the WebViews and HTML would make it easier to rollout multi-platform support.

HTML in its version 5 supports new features like native video support, local databases, and better graphic support. One of the new features is limited support of offline storage (see Hickson (2011)). Storage capacity comes with a standard quota of 5 MB per domain, so while this might not be usable to data intense applications like a MOOC, at least some web browsers allow to turn off this limit and allow unlimited offline storage (limited by local resources). Currently, only a few users are aware of these new possibilities, so the browser will not be the first place where they will look for offline capable functions. However, these possibilities could be used to solve issues like using a device with non-steady Internet connection, for example in a train or a car.

Based on these features HTML5 adds one more possible solution in addition to native and hybrid apps that might be considered from MOOC providers.

5.2 Evaluation of App-Usage

After the app is launched, further research will be needed to evaluate the usage and impact of the app. Questions to be asked are:

- How will users learning behavior change given the additional mobile and offline access?
- How many users will use these new possibilities?
- And for those users using the new app, will there be a relevant impact on their learning achievements, both in comparison to previous courses they visited and in comparison to the rest of the users accessing the course through the web browser only.

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STRATEGIES AND CHALLENGES IN IPAD INITIATIVE

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ABSTRACT

This study examines the impact of iPad integration on teaching and learning activities in a large school district in Midwest United States. Forty social studies classrooms received iPad carts to engage students in learning. Teachers received professional development opportunities in the forms of workshops, conferences, one-to-one coaching, and online communities. The findings showed positive impact on student learning in the areas of digital literacy, engagement, collaboration, productivity, and creativity. Facing shifting pedagogy to learner-centered learning, teachers have also found increased opportunities for collaboration and creativity. Technology anxiety and distraction remain the main challenges for teachers and students. School districts need to promote collaboration in learning circles, one-to-one mentoring, and transformative modeling as the best practice for iPad integration.

KEYWORDS

iPad, strategies, mobile learning, challenges, engagement

1. INTRODUCTION

Mobile learning with iPads has become a common scene in many primary and secondary schools in the United States. iPad allows the opportunities for educators to engage students in personalized learning and active collaborative learning in the classroom. iPads enables learning at a higher level with greater accessibility to online digital resources and the Internet. The implementation of iPad initiatives in K-12 schools (i.e., primary and secondary schools) varies from schools to schools. Some allow complete one-to-one access, in which students have access to the same iPads both at schools and at home. Other schools provide iPad carts for students to access iPads in specific classrooms. This study explores the strategies and challenges in implementing iPad cart initiative in a large K-12 school district in Midwest United States. The purposes of this research are to examine the impact of iPad initiative on teaching practices and student learning and the best practices for iPad implementation.

2. BACKGROUND

The school district in this case study is a large public school in a Midwest city in the United States. The school district has more than 32,000 students with 68% students of color. Sixty-six percent of the student population in the district received free or reduced lunch in the 2011-12. In Spring 2012, the school district began a pilot project to look at the efficacy of using iPads to teach Geography. Four teachers had access to an iPad cart in their classrooms as part of the pilot. In academic year 2012-13, forty teachers, including all 9th grade Geography teachers and 6th grade Studies teachers received iPad carts in their classrooms. All teachers participated in professional training workshops, conferences, and need-based mentoring. Enhanced teaching practice and sound pedagogy need to be embedded in the professional development opportunities for teachers. Professional development should focus on both the content and the performance improvement. Content refers to the pedagogical and technological contents that enable educators to advance student learning. Performance improvement refers to enhancing the educators' capability to do the job well. The following sections describe the PD model and framework.

2.1 SAMR: Pedagogical Model

For the content part of the professional development, Puentedura's (2009) SAMR model aims at transforming learning with technology. SAMR stands for *substitution, augmentation, modification, and redefinition*. At the basic levels, technology can be used to substitute print text and augment traditional face-to-face learning. At higher levels, the use of technology should aim at augmentation (i.e., digital tools as a direct substitution with functional enhancement), modification (i.e., digital tools encourages task redesign), and redefinition (i.e., digital tools lead to the creations of new tasks). Learners are encouraged to work with peers or experts in the field to engage in authentic learning. The project team has developed iPad curriculum and lesson plans to assist teachers to go beyond substitution level.

2.2 Faculty Performance Support Model

In addition to the emphasis on the pedagogical and technological content, faculty performance is also an essential part of the professional development. The Performance-Based Faculty Development model (Fang, 2008) has provided the framework to provide comprehensive support for teachers. The framework focuses faculty support in the five areas: (1) formal training, (2) community of practice, (3) performance support, (4) knowledge sharing, and (5) evaluation.

To implement the model, the project team has adapted specific ways to enrich teachers' learning experiences as described below:

- Formal training
    - Day-long conferences and summer PD workshops: Teachers participated in iPad conferences that took place in June, August 2012, and January, March 2013.
    - Webinar: Synchronous webinar sessions on specific topics were held for teachers who could not attend the monthly meetings
- Community of practice
    - Edmodo: A learning management system, Edmodo, was set up to provide opportunities for teachers to exchange information and share instructional materials.
    - Monthly user group: Teachers participated in the after-school monthly meetings that took place at different school each month.
- Performance support
    - One-to-one iPad innovator: The innovator provided in-class instructional support, curriculum brainstorming, tech consultation, and other instructional services for teachers.
    - Video on demand: The project team created several video tutorials to answer teacher questions when needed.
    - Building IT support: Building IT supports were trained to provide tech support and troubleshoots.
- Knowledge sharing
    - Online resources. The project team maintained a website with videos, instructional materials, educational apps, policy and guidelines for teachers.
    - Google Docs resources sharing: Instructional templates or lesson plans were shared through Google Docs ready for used in the classroom.
    - iPad Curriculum Guide: The guide was created to provide specific information on how to integrate iPad activities into the curriculum for the whole academic year.
    - Q&A via Edmodo: The project team utilized Edmodo to provide prompt replies to teacher questions.
- Evaluation
    - The evaluation included 40 classroom visits, five student focus groups, two teacher focus groups, and online focus group questions. The findings from the classroom visits between February and May also provided feedback for the project team to provide ongoing personalized support for teachers.

3. RESEARCH METHOD

This study has employed an exploratory case study method that examines how the implementation of iPad carts can contribute or inhibit teaching and learning activities in the classroom. This approach can provide a holistic account of the phenomenon under investigation (Yin, 2003).

3.1 Research Questions

This project will address the following research questions:

1. What are the factors that contribute to student learning and teachers' facilitation of learning with mobile devices? Specifically the researchers are interested in exploring the perceived and observable opportunities of iPad integration that enhance student engagement and performance.
2. What are the factors that inhibit student learning and teachers' facilitation of learning with mobile devices? The researchers are looking for lesson learned from iPad integration and participant experiences that are unique in the iPad initiative.

3.2 Data Collection Methods

The research team conducted evaluation of the iPad initiative by collecting data from multiple sources, including:

1. Teacher focus groups: Two teacher focus groups with the sixth grade teachers and ninth grade teachers separately. A total of 11 teachers participated in the face-to-face focus groups.
2. Student focus groups: Five student focus groups with three groups of ninth grade students and two groups of sixth grade students. A total of 25 students participated in the focus groups.
3. Online focus group: Students and teachers who could not participate in the face-to-face focus groups could complete the same focus group questions online. 212 students and 11 teachers completed the online focus group questions.
4. Classroom visits. A total of 40 class visits were made, of which 18 classrooms were observed twice. The research team used a classroom observation form to take notes on the SAMR integration, ISTE NETS alignment, and classroom activities. The pre-visits were conducted between February-March and the post-visits were conducted between April-May, 2013.

All focus groups interviews were recorded and transcribed. The transcripts and online responses were analyzed using NVivo, a qualitative research software program. Several themes on student learning, teaching practices, challenges, and best practices were extracted from the data.

3.3 Data Analysis

Based on the multiple data sources, the analyses focus on the opportunities and challenges in student learning and teaching practices. Participants-recommended best practices were also discussed.

3.3.1 SAMR Integration

Based on analysis of the classroom observation notes by the research team, the 18 classrooms that have received pre- and post-visits have shown improvement in SAMR integration. During the pre-visits, the iPad activities in nine out of 18 classrooms were at the substitution level such as website information look up or reading E-books. None was at the redefinition level. During the post visits, the majority (seven out of 18 classrooms) was still at the substitution level. However, there was an increase at the augmentation and redefinition levels, which indicated that more teachers were integrating activities that engaged students in project-based learning or critical-thinking (Figure 1).

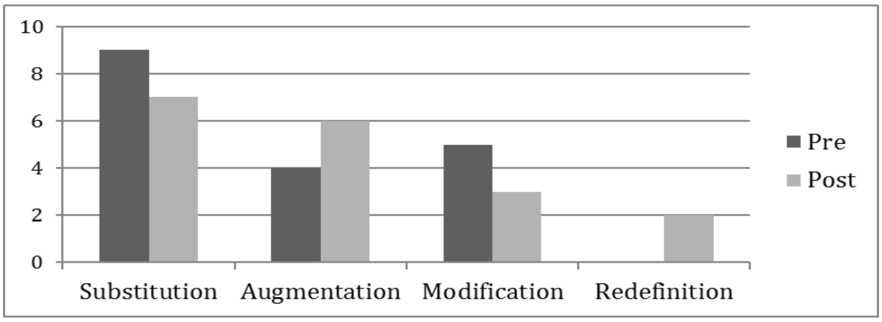

Figure 1. Comparison of SAMR integration level between pre- and post-classroom visits

3.3.2 ISTE NETS Alignment

The International Society on Technology for Education's (ISTE) National Education Technology Standards (NETS) have been adapted by all fifty state as the criteria for technology integration. In examining how the iPad activities have addressed the ISTE NETS, the research team observed the classroom activities and came to an agreement on the standard(s) that the activities addressed before recording the results on the observation form. The research team may mark more than one ISTE NETS in each classroom visit because the instructional activities might address multiple technology standards. The data indicated that the majority classroom activities have focused on research and information retrieval during the first classroom visits. However, during the second visits, the data showed an increase of activities in communication, collaboration, creativity and critical thinking. The findings reveal that although using iPad for research and information retrieval were common practice in most classrooms, teachers have gradually moved beyond the basic level of technology integration and strived to engage students at multiple levels (Figure 2). Notably, all ISTE NETS activities have increased during the post visits except for digital citizenship. The reason is that the figure is based on observable activities. Observers checked all relevant ISTE NETS criteria based on the activities during the visits. The observers noted that digital citizenship was emphasized strongly at the beginning of the iPad initiative. Once students have demonstrated understanding of the concept and applied to their learning, teachers focused less on digital citizenship and more on other ISTE NETS activities.

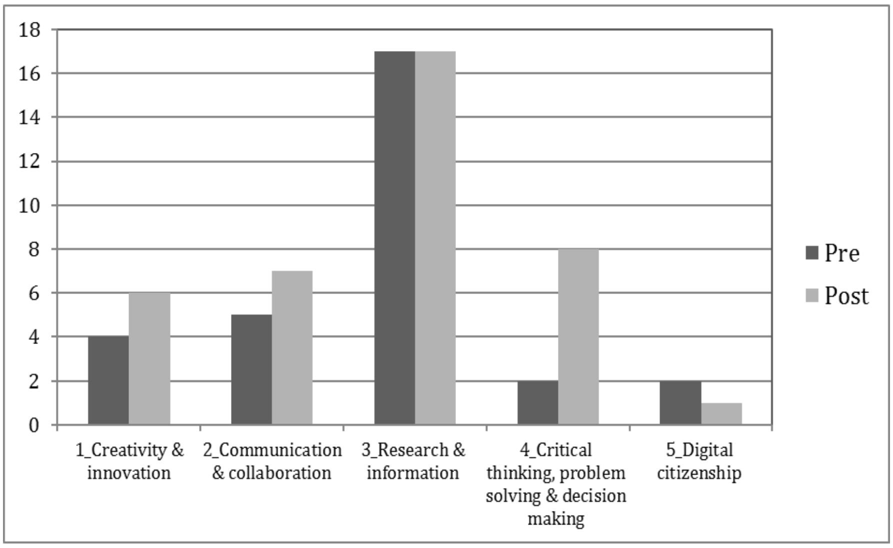

Figure 2. Comparison of ISTE NETS integration: pre- and post-classroom visits

3.3.3 Student Learning

Based on the student focus group data, student responses revealed four major themes on the impact of iPad activities on their learning (Figure 3):

1. Collaboration and creativity: 11% of the responses showed that students had more opportunities to collaborate with each other through small group projects on iPad. The multimedia features of iPad allowed students to brainstorm with their peers and be more creative in their projects.
2. Engagement: 14% of the responses indicated that students have strong interest in utilizing iPad for more classroom activities. They found that the class went by much faster when iPads were in use.
3. Productivity and Apps: Students found themselves more efficient in producing projects and completing assignments. The multitude of multimedia apps such as camera, poster, presentation, and screencast apps afford them the opportunities to produce projects that were not available on paper.
4. Digital Literacy: The majority of students responses (23%) indicated that they have increased knowledge in digital literacy and become more efficient in retrieving information.

The following student quote sums up well on student creativity:

> "*The iPads have increased my creative learning by giving me a chance to come up with new ways of learning. By letting me create websites that people could visit to learn new and interesting facts that they didn't even know about.*"

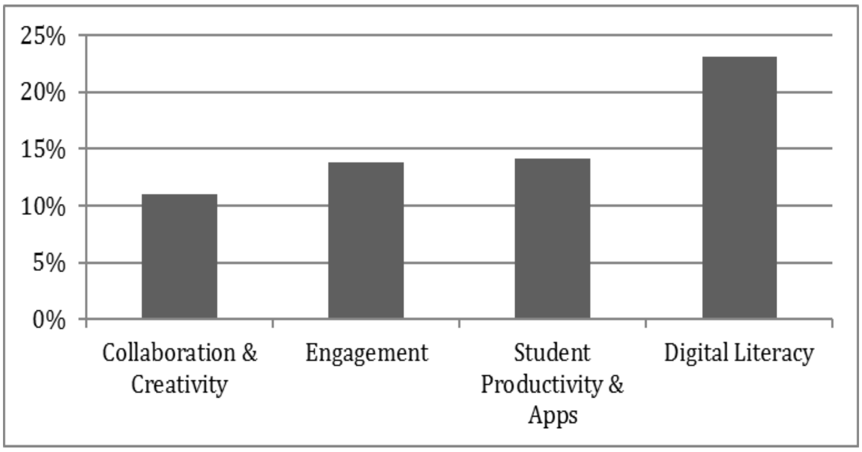

Figure 3. Areas of improved student performance

3.3.4 Teaching Practices

The teacher focus group data showed that through iPad integration teachers have enhanced their teaching in the following ways (Figure 4):

1. Creativity and Productivity: With iPad integration, teachers found themselves more creative and productive in the instructional activities. Many apps such as Haiku Deck or Educreations have presented opportunities for them to be more creative with presentation and students assignments.
2. Professional Development: Through district-sponsored PD and learning circles, teachers were able to receive continued support in improving their skills and knowledge in iPad integration.
3. Shifting Pedagogy: Teachers recognized a needs to integrate more student-centered activities and personalized learning for students through iPad.
4. Modeling: Teachers found it most efficient to have other teachers modeled lessons, project, or classroom management ideas.
5. Teacher Collaboration: The PD workshops and online community of practice have provided opportunities for teacher collaboration. Five teachers from three high school collaborated on an international project-based learning in which their students used iPads to develop a neighborhood project to exchanges information with international students in Taiwan and Philippines.

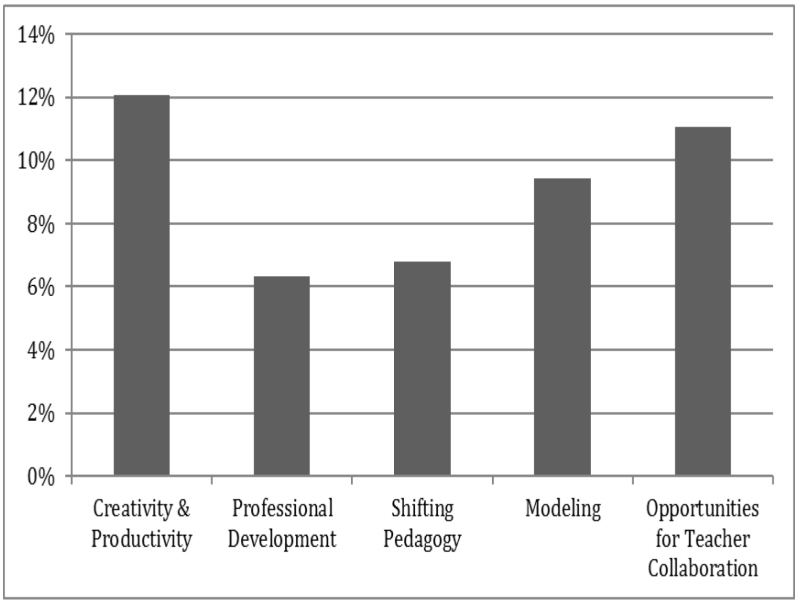

Figure 4. Opportunities for teaching practices

The following quotes from the teacher focus group provided the supporting evidence on the pedagogical shift in their teaching practices:

> *" I use it all the time. To have something extra, to have something they really have the desire to get on, instead of opening a book and getting a worksheet, they're like I'm going to get on and make something and do something- 'look at mine, no look at mine!', it's so much bigger. I can go and take my iPad with me on a field trip and take tons of pictures and make something and get them geared up. It really does evoke some of that motivation for learning."*

> *"I know I used my teacher iPad a lot and when the apple TV was installed a whole new world was opened for me and I could show them the globe on the Smartboard or I could show them a clip of the Sioux{Dakota} Indians from the History Channel and it just allowed me to bring so many things into the classroom that I didn't have to carry or lug or go to a different website."*

3.3.5 Challenges

Technology integration requires multi-layer support in a large educational institution. The challenges faced by the teachers and students are summarized below:

1. Technology anxiety: The iPad cart was a completely new technology for the majority teachers. There was a high degree of anxiety among teachers in adapting the new technology and revised curriculum in addition to their regular teaching responsibilities.
2. IT Support: Many teachers have reflected that requests for tech support were not always resolved in a timely manner, which led to high degree of frustrations and stoppage in utilizing iPad carts.
3. Pedagogical applications: Teachers have indicated that one key challenge is to locate more pedagogical sound examples for adaptation into their own teaching. It takes time for teachers to integrate best practices into the daily classroom activities.
4. Distraction: Students have indicated that it is easy to get off task with so many different apps and easy access to websites on iPad. It is also difficult for teachers to manage the iPad when students went off tangent onto other tasks that are not central to their assignments.

3.3.6 Best Practices

After eight months of iPad integration, teachers have made the following recommendations for best practices:

1. Opportunities for teacher collaboration: Teachers appreciated having time to explore and collaborate with each other during professional development workshops. Having the opportunities to explore new apps, try new activities, bounce ideas back and forth, and learn from other’s mistakes could all provide valuable lessons in the integration process,
2. Exemplary projects and peer modeling: Teachers felt strongly about seeing more exemplary works and effective teachers in action. They want to see or hear how other teachers implement a lesson plan that results in quality student work.
3. Learning circles and mentors: Learning in small groups or with a mentor are also efficient ways for continued professional development. Team members can keep each other updated on their project ideas and share results of their projects. They could also implement the same project and compare notes on student performance.

One teacher has summed it up well on the best practice:

> “making the teachers the kids, getting them to find out what’s fun about this app or how it can be used or actually-- I know when I first got my iPads, they were messing around and going to places they shouldn’t go. I showed them another student’s work, and they were like ‘I can do better than that!’, and it was so good that I think if teachers had that opener to see how it can be used practically, it would be used more.”

4. CONCLUSION AND RECOMMENDATIONS

The iPad initiative has no doubt generated high degree of learner engagement and led to fundamental shift in teaching practices. At the conclusion of the first year iPad rollout, there were many lesson learned.

- Lesson 1: Teaching modeling through one-to-one mentoring or small group conferencing proves to be the most effective way to encourage novice teachers. It is important not to overwhelm beginning teachers with multiple apps or lesson ideas. Starting with one small project on one app that shows result would be the best practice. For example, using Edmodo to collect student assignments or encourage small group activities could reduce issues associated with paper assignments and enhance student communication.
- Lesson 2: Teachers have observed improved student engagement and performance improvement when iPad activities are at the level of modification or redefinition based on the SAMR level. A well-prepared lesson that promotes student communication, collaboration, and problem solving would keep students on task. Instructional activities that required students to work on substitution task such as information search or completing worksheets would yield a higher rate of student distraction to none-relevant activities.
- Lesson 3: Technology anxiety could decrease both student and teacher interests in iPad-related activities. When faced with technical challenges without the appropriate IT or instructional support, teachers and students would quit and minimize the use of iPads in the classrooms. A teacher might have a wonderful lesson idea, however, without appropriate tech support, the project idea would not move beyond the conceptualization stage.

Based on the findings on the opportunities and challenges in the iPad initiative, the project team would make the following recommendations:

1. Better infrastructure support: The success of the iPad initiative requires concerted effort from all parties involved. The project team needs to continue working with leaders in Teaching and Learning and the IT Divisions at the central office. On the ground, school principals and IT tech support also need to be on board to support the student learning and teacher performance.
2. Integrated professional development opportunities: Teacher feedback on the multiple professional development opportunities has been extremely positive. The use of 1:1 iPad Innovator, the day-long conferences, and immediate feedback through classroom visits will continue to lend strong support to faculty in iPad integration.

3. Innovative pedagogy through best practices: iPad the device can be used as an E-Reader, entertaining gadget, or personalized learning tool. As many teachers pointed out that one cannot continue the same instructional practices with iPads. Educators need to leverage the innovative features of iPad to engage learners. Promoting best practices that advocate authentic and innovative instructional strategies through teaching grants, awards, or coaching could encourage more meaningful iPad integration.

One-to-one learning with iPad has great potentials to enable students to develop passions through personalized and media-enhanced learning environment that keep students connected and engaged. The iPad initiative has demonstrated that with effective instructional activities, educators can improve student performance and prepare them for future academic challenges.

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BLENDING CLASSROOM TEACHING AND LEARNING WITH QR CODES

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ABSTRACT

The aim of this case study was to explore the feasibility of the Quick Response (QR) codes and mobile devices in the context of Finnish basic education. The interest was especially to explore how mobile devices and QR codes can enhance and blend teaching and learning. The data were collected with a teacher interview and pupil surveys. The learning outcomes were measured with the test results after the experiment and with the pupil's self-evaluation. From a learner's point of view, the QR activity was motivating and brought much-wanted variation to the traditional school day. The QR problems encouraged the pupils to persevere with the problems, an effect which led to good learning outcomes.

KEYWORDS

Mobile Learning, Pedagogy, Quick Response (QR) Codes.

1. INTRODUCTION

Modern information and communication technologies, such as mobile technologies and Quick Response (QR) codes, have great potential to improve teaching and learning because mobile technologies enable learning across multiple contexts, through social and content interactions (Crompton, 2013). In other words, learners can learn anytime and anywhere and learning can be personalized, situated and authentic (Traxler, 2009).

Research on mobile learning has been conducted all over the world, but only a small portion of the studies have addressed the use of QR codes in education (Law & So, 2010). Findings from the scarce but rich studies have, however, indicated that there is a variety of ways to use QR codes in an educational context. Because QR codes are versatile, they can support learning in different contexts. These contexts can include the woods, the gym, school surroundings and learning materials could consist of videos, texts, pictures and more (Rikala & Kankaanranta, 2012). In other words, QR codes can expand the learning experience and provide authentic tasks that take place in real-world settings. With the QR code embedded in the environment, students can obtain contextual or location-aware information (Osawa et al., 2007). QR codes can also enrich paper-based materials so that the material serves different types of learners (Chen et al., 2010). In addition, QR codes allow the implementation of systems based on paradigms such as just-in-time and collaborative learning (De Pietro & Frontera, 2012).

However, systematic empirical measurements and investigations of learning outcomes are lacking (Ozcelik & Acarturk, 2011). This study explores the impact of QR codes and mobile devices on pupils' learning outcomes and motivations as well as looks at how mobile devices and QR codes can enhance and blend teaching and learning. This paper focuses on the process and impact of the implementation of the QR codes and mobile devices in Finnish basic education settings. The data were collected with a teacher interview and pupil surveys. The learning outcomes were measured with the test results after the experiment and with pupil's self-evaluation.

The following sections describe QR codes in an educational context. The paper continues with the sections on the research design and the results and it concludes with reflective remarks and proposals for future research.

2. QR CODES IN EDUCATIONAL SETTINGS

The study of QR codes in education can be placed in the context of mobile learning. However, QR codes are not designed in educational terms. These two-dimensional barcodes were originally intended for tracking automobile parts in factories but nowadays they have a much broader purpose (Shin et al., 2012). QR codes have become widely popular because they provide a large amount of data comparatively quickly. QR codes can contain information such as text, URL links, or other data that can direct users to sources of further information about a particular place or subject. Users with a camera phone equipped with a QR code reader application and Internet connection can scan QR codes to display text, open a web page, get GPS coordinates, or perform some other similar action (Lee et al., 2011).

Because QR codes are not designed in educational terms, it is important to see the technology as an enabler. The aim is to explore how QR codes can be effectively integrated into teaching practices, which means the focus should therefore be more on the learners and pedagogy than on the technology itself. For this reason the use of the codes should promote learner-centered learning, not bind teaching and learning to mobile technology (Zhang et al., 2010).

QR codes can meet the needs of learners in a range of ways. First, it is possible to enrich paper-based-materials to serve different types of learners (Chen et al., 2010). For instance, QR codes in paper-based tasks can contain links to multimedia resources such as audio materials or video clips. Law and So (2010) noticed that having the codes in paper-based tasks provide an efficient and flexible way for students to obtain the resources ubiquitously. Second, QR codes can guide learners through the self-assessment process. Law and So (2010), for instance, used the codes to guide learners through the self-assessment process. The QR code printed on the worksheet directly linked to a web page with the right answers and guided the learners through the individual exercises. The same kind of self-assessment process was observed in study by Rikala and Kankaanranta (2012). Teachers can also give directions and information to students on how to complete their assignments. In art workshops, QR codes can be placed, for example, on pieces of equipment such as different kinds of brushes, or in an engineering workshop on different electronic equipment to guide students in their use. Rikala and Kankaanranta observed a situation where QR codes guided students in how to use gym equipment. Third, QR codes provide a flexible way to share materials. Robertson and Green (2012) reported on how learners can find pictures of famous figures and generate a code for that figure. Learners can also produce and share reports or other materials online. In Rikala and Kankaanranta students shared their reports with others as a way of guiding the students' self-assessment process. When the focus is on learners, the use of the codes supports learner-centered learning and enhances students' motivation and excitement. Rikala and Kankaanranta also noted that students were curious about the new approach and that they found QR codes motivating.

The impact of interaction on learning cannot be underestimated. The philosophy of social constructivism, for instance, views learning as collaborative and it emphasizes social interaction (Koole, 2009). The social aspect of learning can also be enhanced with QR codes. In the studies by Susono and Shimomura (2006), Chaisatien and Akahori (2007) and Al-Khalifa (2008), students used mobile phones and QR codes to send questions, comments and suggestions to the teacher during the lecture. Al-Khalifa (2008) argued that with a QR-code based system students can ask questions and make comments without embarrassment. At best, this approach supports communication and information transfer. QR codes can also support the implementation of systems based on the collaborative learning paradigms, among others (De Pietro et al., 2012). Trail activities, for example, can be organized in as a collaboration or a competition between students (Law and So, 2010).

QR codes are very versatile. Lee et al. (2011) found that with QR codes, teachers can create customized guidebooks for individual field studies and that students can learn more effectively because the code only contains information that is relevant to the matter at hand. They furthermore noticed that QR code activities help integrate digital materials with field trips in a motivating way. In other words, QR codes support a variety of teaching practices.

However, the use of QR codes in education is still in its infancy. The main feedback from the teachers is that the planning of QR activities is an arduous task if one does not know how to utilize them, because it simply takes too much of the teachers' time and energy to organize QR activities (Rikala & Kankaanranta, 2012). In this paper, we address this issue as well as others in our discussion of one case utilizing QR codes in an educational context.

3. RESEARCH DESIGN

This is an exploratory case study that examines the feasibility of the QR code activity and mobile devices in one basic education context in Finland. The case study was conducted as part of the Personal Mobile Space project at the University of Jyväskylä, Finland (see Kankaanranta, Neittaanmäki & Nousiainen, 2013). The use of the case study method is appropriate because it provides an in-depth examination and reveals perspectives, opinions and expectations of smart phone usage and QR code activity. The case study method was specifically chosen because only a few mobile learning studies have addressed the use of QR codes in education (Law & So, 2010). Another reason was that the test group and control group research frame would have been very challenging. The challenge stems from how the Finnish education system is set up. The system offers everybody equal opportunities for education. There are no gender-specific school services nor are students channeled to different schools or streamed. Students are not divided corresponding to their level of performance, all of which makes groups very heterogeneous. For these reasons, the decision was to focus only on one case. This case study examined one Grade 5 classroom in Central Finland. The participants included one teacher and her pupils. Twenty-four pupils (11 girls and 13 boys) aged 10–11 years participated in the Math Trail QR activity for two weeks.

3.1 Research Questions

This study addressed the following research questions:

- How do QR codes and mobile devices impact pupils' learning outcomes and motivation?
- How can mobile devices and QR codes blend teaching and learning?

By addressing these research questions, we can make recommendations on what the key characteristics are of sustainable integration of these technologies into a formal education context.

3.2 Instructional Design

The QR code implementation and its contents were planned together with the Grade 5 teacher. She has worked as a teacher in basic school for over ten years but this was the first time she had taken advantage of mobile devices as part of her teaching practices. She commented: "This fall I thought that I need to get some new ideas and some kind of a boost to my work and something nice and exciting for the children."

The overall objective of the implementation was to enhance the pupils' mathematical skills and to bring much-wanted variation to the school day. The subject and objective of the experiment was to learn about decimal numbers. Mathematics was a good choice for a learning domain because according to Hwang and Tsai (2011), the ratio for mathematics in mobile learning research had been relatively low.

The results of short-term pilot experiments have indicated that students are excited when they are able to go outside the classroom during the lesson (Rikala & Kankaanranta, 2012). For this reason, a Math Trail was chosen as the form of the activity. In short, a Math Trail activity is a walk to discover mathematics. The walk can be organized almost anywhere – in a neighborhood, a park, a zoo, and elsewhere. A map guides the learners to places where they can formulate, discuss, and solve mathematical problems. The very earliest Math Trails appeared in England and in Australia in the mid-1980s, but as the idea of the Math Trail has spread, people have adapted it to suit their specific needs. The Math Trail is a flexible idea and can easily be amended to meet the needs and inventiveness of the users in many situations and contexts (Shoaf, Pollak & Schneider, 2004).

In this case, the Math Trail was located in the school environment (e.g., in corridors, in classrooms, and on furniture). During the Math Trail experiment, each pupil used a smart phone and a map of the trail including QR code locations. Contrary to the original idea of the Math Trail, the problems used were the same ones pupils were currently solving at school. The teacher designed textbook-like decimal problems (see Figure 1). The online forms (implemented with HTML and JavaScript) and QR codes were prepared by the researcher. The decimal problems needed to be relevant to the school curriculum, which is why the problems were the same as pupils were solving at school. The Math Trail included 65 decimal number problems ranging from easy and to challenging. The purpose was to give the learners control over the pace at which they learn and promote fulfilment from their achievements. The aim was to ensure that the learners would think that they were treated as individuals and that they would be content and learn at their own preferred pace.

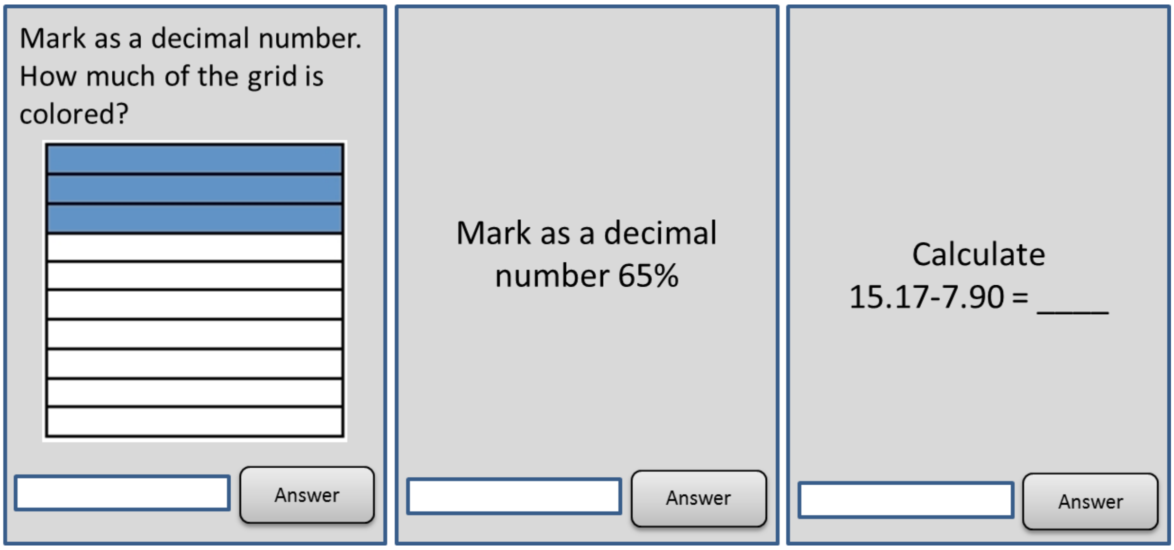

Figure 1. Examples of the decimal problems

At the beginning of each lesson, the teacher taught the theory and the pupils solved five problems from the textbook. After solving these five textbook problems, the pupils followed the Math Trail. Along the trail, the pupils could also use a paper and pencil to solve the problems, making the experiment a blended example of traditional and mobile learning approaches.

At each QR code location, the pupils answered a problem by scanning the code and submitting their answer using the online form on the mobile device. If the answer was correct, the pupil would receive a hint for the next QR code location. The Math Trail was intended as a self-directed and individual activity, but cooperation was allowed.

3.3 Data Collection

The research data were collected with surveys and a teacher interview. The questionnaire and interview questions covered the core aspects of mobile learning and measured the perspectives, opinions and expectations of the smart phone usage and QR code activity. The learning outcomes were measured with the test results after the experiment and with the pupils' self-evaluation.

In the pupil questionnaire, the questions covered three areas: smart phone use (5 questions), QR code activity (10 questions) and self-evaluation of learning (1 open-ended question). Answers were given in three forms: a three-point scale (a lot, a little, not at all), agree/disagree or yes/no. The teacher interview resembled an informal discussion but it followed some key themes.

4. THE RESULTS

After two weeks of activity the pupils completed a questionnaire. Each pupil completed the questionnaire alone. The teacher interview was also carried out immediately after the experiment. The interview lasted for 39 minutes. The interview was recorded, transcribed and analyzed using a thematic analysis method. Soon after the experiment the teacher organized a test for pupils. The test contained similar textbook-like decimal problems and it was evaluated using a scale from 4 to 10 (where 4 is failed and 10 is excellent). The teacher reported the test results to the researcher.

4.1 How did the QR Codes and Mobile Devices Impact Pupils' Learning Outcomes and Motivations?

From a learner's point of view, the Math Trail was motivating and brought much-wanted variation to the traditional school day. The pupils strongly agreed that the QR activities were an interesting and exciting new way to learn mathematics, and that they would like to do QR activities again (See Table 1).

Table 1. Pupil's feedback about learning with QR codes ($N = 23$)

	Yes	No
I would like to do QR activities again	100%	-
QR activities were an interesting new way to learn mathematics	100%	-

In their open-ended answers, 50% of the pupils highlighted that they had learned mathematics with QR codes (See Table 2). However, 38% of the pupils claimed that they did not learn anything new with QR activities. The boys claimed more often than girls that they did not learn anything new. Some pupils mentioned the problems as being too easy.

Table 2. Pupil's self-evaluation of learning (n=23)

		Examples of pupils' questionnaire quotes
I learned mathematics with QR codes	50%	A boy: "I learned to solve decimal problems a little bit better." A girl: "Solving math problems better." A boy: "It was easier to solve math problems with QR activities." A girl: "I learned to solve different kinds of decimal problems."
I did not learn anything new	38%	A boy: "I did not learn anything because I already knew how to solve them." A boy: "It was a new way to learn but tasks could have been more difficult." A boy: "Nothing much" A girl: "Nothing new."
I learned to use a smart phone	8%	A girl: "To solve decimal problems and to use a smart phone." A girl: "I learned to use a different kind of smart phone." A girl: "I learned to navigate and to use a smart phone."

The teacher was satisfied with the experiment. She said that the Math Trail inspired and motivated pupils and that for once the pupils' ability to use smart phones benefited the learning. The teacher presumed that the pupils' motivation emerged from the autonomy they were given. The learners had control over the pace at which they learned and were able to solve challenging tasks in an engaging way instead of the traditional textbook exercises. The teacher furthermore described that along the Math Trail pupils even solved problems she had not yet taught them. The QR implementation, therefore, encouraged pupils to work through the problems, which led to deeper knowledge and affected their test grades as well.

In Finnish primary school, pupils' test results are evaluated using a scale from 4 to 10 (where 4 is failed and 10 is excellent). According to the teacher, seven pupils received a grade of 10 (excellent), ten pupils received a grade of 9 (very good), six pupils received a grade of 8 (good) and one pupil received a grade of 7 (satisfactory). The teacher was surprised that the pupils' test results were so good despite the reduced amount of textbook practice, commenting: "Although we practiced less than normal, something more happened in the pupils' brains." The new way to learn mathematics inspired and motivated girls in particular, but boys were also engaged and claimed that QR codes made decimal problems more interesting.

The design and implementation of math problems requires care. This requirement was discovered along the Math Trail when there arose one error. It stopped the whole exercise and pupils were confused. The teacher commented that "I accidentally provided the wrong answer to one math problem. The pupils were not able to solve it and the whole exercise stopped, after which the pupils had to choose the next QR code at random." Hence, rushing with the planning and implementation of the math problems can lead to many challenges. The pupils' motivation can suffer if they encounter problems or the problems are not challenging enough. According to pupil feedback, there should be a wide range of problems, because some pupils found them too easy. The Math Trail served most of the pupils' needs, but there were two pupils who could not participate because they were receiving remedial or special needs education in mathematics. For these two pupils, the QR code implementation was too difficult. Commenting on this difficulty, the teacher stated

> It did not occur to me when we were planning this Math Trail that these two pupils would not be able to participate because they progress slower. In retrospect, there should have been even more variation in the math problems. Now there was quite a strong dissimilarity experience for these two pupils and that was not good.

In other words, by designing a wide range of tasks, the Math Trail can be personalized in such a way that it can serve different types of learners, even pupils who receive remedial or special needs education.

4.2 How Mobile Devices and QR Codes Blended Teaching and Learning

The Math Trail experiment turned out to be a successful experiment. It blended and enriched traditional teaching methods and classroom learning. The math theory was taught with traditional methods and in a teacher-centered way but along the Math Trail pupils were able to work at their own pace and in their preferred manners. Some pupils were quick to solve problems and the teacher had to design another Math Trail for them, whereas other pupils did not complete the first trail. The Math Trail activity also encouraged social interaction. It was planned as a self-directed and independent activity, but cooperation was allowed. Each pupil solved the problems in their own preferred way and at their own pace but, according to the teacher, the pupils also regularly formed groups and solved the problems together.

The context where the mobile devices and QR codes were used was interspersed with traditional classroom learning. The math problems were planned in such a way that they had relevance to the school curriculum and therefore the implementation was not as authentic as it could have been. QR codes were placed around the school. In a sense, learning was extended outside the classroom. However, at its best, this kind of implementation could be arranged in a park, a zoo or almost any place where pupils could discover and solve problems relating to what they find (Shoaf et al., 2004). Differently implemented QR code activities could support situated and authentic learning.

According to the teacher, the phones functioned surprisingly well and only once or twice did the battery run out during the Math Trail or the pupils report problems. According to the teacher, the pupils instantly learned how to use the smart phones and QR code reader. Only a few pupils had problems and needed help during the experiment. This is consistent with the survey results as only 13% of the pupils expressed that they had to learn many things before they learned how to use the phone and QR code application. Because there were only a few problems, the activity went smoothly and the teacher as well as the pupils were satisfied.

The online form embedded in the QR codes was implemented by the researcher with HTML and JavaScript. This part of creating the task was too difficult for the teacher. The teacher commented: “If I were to take this kind of implementation as a teaching method, I should study more information technology.” She also suggested that Math Trails or QR code activities could be included in and enclosed with the textbook. This would be the easiest way for the teacher to organize the QR code activity.

5. CONCLUSION

The present study aimed to examine the process and impact of implementing QR codes and mobile phones in the context of Finnish basic education. The interest was to explore the impact of QR codes and mobile devices on pupils’ learning outcomes and motivations as well as to explore how mobile devices and QR codes can enhance and blend teaching and learning.

The Math Trail experiment was successful. It blended and enriched the traditional teaching methods and classroom learning and indicated that, with the QR codes, it is possible to arrange motivating and meaningful activities for pupils. However, the implementation was not as authentic and spontaneous as it could have been. The math problems were planned so that they had relevance to the school curriculum, which negatively affected the authenticity of the task. At their best, QR codes can expand the learning experience and provide authentic tasks that take place in real-world settings.

Even though the experiment was not as authentic and spontaneous as it could have been, pupils found it motivating. The pupils even tried to solve problems that they had not yet been taught. The QR implementation, therefore, encouraged the pupils to work through problems, which perhaps also led to deeper knowledge. This process had an effect on pupils’ test grades as well, which were good.

The experiment highlighted the importance of pedagogical design. Even though the Math Trail served most of the pupils' needs, it also indicated that a wide range of tasks is required so that the activity can serve different types of learners and even pupils who receive remedial or special needs education. These findings are consistent with the fact that the individual learner's cognitive abilities, memory, emotions, motivation, attitudes and experiences play a significant role in the mobile learning process (Koole, 2009). In other words, the appropriate way to utilize mobile technology in education settings requires balance. Technology use must be matched with the curriculum, the learners' needs and human interactions.

Traxler (2009) has argued that mobile learning is an inherently noisy phenomenon where context is everything and confounding variables abound. This potential for confusion is why the positive results may be caused by other factors. The novelty effect, for example, is one of the intrinsic shortages in mobile learning research. This effect, according to Cheung and Hew (2009), means that learners and teachers are more likely to use technology because it is new to them compared with participants who have used technology for a longer period of time. Hence, the effect may bias the results. Thus, to clarify the findings, more thorough evaluations should be conducted. Especially, the repetition of the approach would give more evidence of the feasibility of the approach. In particular, learning outcomes and motivation should be measured and investigated more systematically. However, the findings in this study provide some insights and best practices of QR code usage in a basic education context. The study provides a good basis for continuing research into the educational use of QR codes.

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PROGRAMMING EDUCATION WITH A BLOCKS-BASED VISUAL LANGUAGE FOR MOBILE APPLICATION DEVELOPMENT

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ABSTRACT

The aim of this study is to assess the impact upon academic success of the use of a reference block-based visual programming tool, namely the MIT App Inventor for Android, as an educational instrument for teaching object-oriented GUI-application development (CS2) concepts to students; who have previously completed a fundamental programming course that involved education of structured programming concepts using C# (CS1). It has also been studied whether impacts upon CS2 success of factors such as previous success in CS1 and prior high school experience in programming, have a relationship with the impact upon CS2 success from the use of the blocks-based instructional tool. The research; which has a post-test only quasi-experimental design; has a sample comprised of 101 Undergraduate students who are taking up the CS2 course at a Department of Computer Education and Instructional Technologies (CEIT).

KEYWORDS

Programming education, app inventor, programming paradigms, mobile application development, programming blocks

1. INTRODUCTION

Although programming education is vital to the development of many industries and a highly popular subject in many curriculums of today's academic institutions, it is a known fact that it poses great difficulties to novice students who most often fail to achieve desired results at introductory levels of it (Kinnunen and Malmi,2008;Özdener,2008; Mccracken et al., 2001; Soloway, Ehrlich, Bonar and Greenspan 1983). The fact that average academic success in worldwide programming education is below desired levels, shows us that programming education has its own exclusive challenges. According to Robins, Rountree and Rountree (2003), students need to possess high-levels of cognitive skills for overcoming the said challenges and also, lecturers need to use appropriate teaching strategies.

Papert, who has extensively studied on how to teach programming more effectively; has created the Constructionist learning theory, which is based on Piaget's idea of "learners intrinsically constructing knowledge" and which suggests that the most effective method for learning is through the construction of personally meaningful concrete artifacts with a social aspect to them (Papert and Harel 1991). This theory has led to creation of the blocks-based visual programming languages to be used in programming education in order to make things simpler and more personal for students; although the initial idea was to be employ these for offering easier-to-use tools to end-user developers (Mohamad, Patel et al. 2011).

As previously mentioned, although block-based visual programming languages are thought to designed for the benefit of end-user developers (Mohamad, Patel et al. 2011), several studies also propose similar approaches, for example, with physical real-world blocks, as programming education tools for small children (Wyeth and Purchase 2000). Other studies have discussed the effect of education with tangible blocks increasing interest and success in programming in children (McNerney 2004, Horn and Jacob 2006), and although positive results with the use of block-based tools in programming education have occasionally been reported (Horn and Jacob 2007, Wang, Zhang et al. 2011), it is thought that there is a need for further experimental studies that display concrete results.

Another approach that has seen recent use for increasing the motivation of students towards programming education is the use of smart mobile devices in programming education. Smart mobile devices are becoming vastly popular; in that, as of the year 2011, there is at least one software application in the mobile phone of every other American citizen (Purcell 2011). Considering the high usage ratios and the popularity among the young generation of smart mobile devices, it can be expected that educational applications that target these platforms should gain interest from students (Rau, Gao et al. 2008).

According to Dvorak and Buchanan, students allocate more time to study for lessons that are taught with new tools (Dvorak and Buchanan 2002). And perhaps for this reason, Mahmoud and Dyer have proposed in their teaching model -which has been fashioned in parallel with their study conducted at Guelph University- to give programming education to students by using BlackBerry branded smartphone devices (Mahmoud and Dyer 2007). However, there is no experimental data that shows how using this smart device as an educational tool for teaching programming would affect student success. Tillmann et al. Have also proposed a system in which students would get all the programming education entirely over smart mobile devices, and although they have not tested the use of this system, they have claimed that the future of programming education lies in "mobile programming" (Tillmann, Moskal et al. 2012). Again, in this context, Kurkovsky and Bhagi have each run separate studies that aimed to teach students programming through game development for mobile platforms and they have both emphasized the positive student motivation that has been observed. However, both studies have not made it clear the level of success achieved by students in programming education, especially as compared to conventional syntax-based approaches (Kurkovsky 2009, Bhagi 2012). Another unanswered question is whether the use of mobile devices would affect all students the same way. All in all, a review of current literature shows that, although use of smart mobile devices as educational tools for increasing student motivation in programming classes has already been discussed, there is need for further experimental research in this matter.

A project developed by Google Inc. for enabling end-users to develop their own apps on the Android mobile operating system (although later discontinued and adopted by the MIT Media Lab), the App Inventor for Android (AIA) is a blocks-based visual programming language (BBVPL) that has achieved popularity in the recent years. With its potentially promising source for student motivation by enabling development of personally meaningful mobile apps on student-owned devices; and an easy to understand blocks-based visual programming approach, App Inventor soon made researchers think that it could prove to be a valuable tool in programming education. As such, it has been proposed that this blocks-based app development tool for mobile platforms could be used in programming education by Karakus and his colleagues (Karakus, Uludag et al. 2012) and it has been also claimed by Wolber that it is a useful tool for increasing student motivation towards programming classes (Wolber 2011). It could therefore be beneficial to determine experimentally whether the use of MIT App Inventor for Android would have a positive impact upon student success in programming education. Particularly, this study proposes the use of MIT App Inventor for Android as a transitional tool from the console based procedural approach stage in programming education to the object-oriented GUI-application development stage. As opposed to most previous research with App Inventor, all the participants in the study have prior experience in programming both at a CS1 course where they received the console based procedural programming education, with some of the participants having even more, pre-university programming experience whom they mostly received at vocational high schools.

2. PURPOSE

The aim of this study is to investigate the effects of using a blocks-based visual programming language for app development in mobile platforms as an educational tool for teaching programming at the object oriented GUI-application development (will be referred to as CS2 from now on) phase upon the academic success of undergraduate students. Additionally, it has been investigated whether there is an interaction between effects from factors that influence object oriented GUI-application development related academic success, such as previous success level at a prior university programming course that involves fundamental education in structured programming concepts (will be referred to as CS1 from now on) and high-school experience in programming prior to university education (if any) upon student success; and the effect from the tool that has been used. In this context, the following hypotheses have been tested:

- The average post-test results of the experimental group, who used the Blocks-Based Visual Programming Language (will be referred to as BBVPL from now on) will be significantly greater than that of the control group who used a conventional syntax-based object-oriented programming language (will be referred to as SBL from now on) for desktop application development (**Hypothesis 1**).
- A factorial analysis of variance shall reveal a significant three-way interaction between the effects of the following factors upon academic success of students in object oriented GUI-application development: the factor of educational tool employed (BBVPL / SBL), the factor of high school experience in programming education, (experienced/inexperienced) and the factor of previous success at the CS1 university course (successful/unsuccessful) (**Hypothesis 2**).
- A comparison of average academic success between the so-called “novice” sub-groups, which have been determined as students who lack high-school programming experience and who have been previously unsuccessful at CS1 course, shall reveal a significant difference in favor of the sub-group that has used the BBVPL against the sub-group that used SBL (**Hypothesis 3**).

3. METHODOLOGY

3.1 Research Design and Sample

The study follows a posttest only quasi experimental design. Pre-tests have been used however, to control for groups equivalency. The study sample is comprised of 101 2nd year undergraduate students at the Department of Computer Education and Instructional Technology, who have taken up at the previous semester the CS1 course, which involves teaching programming basics through the structured /procedural programming paradigm and by the development of console applications for the desktop PC using .NET (C#) language. The students belong to two groups, namely the daytime education and evening education; which have been randomly assigned as the experimental and control groups for the research. The software application development projects undertaken throughout the CS2 course have been taught by using a reference Blocks-Based Visual Programming Language for Mobile Application Development (BBVPL), namely the MIT App Inventor for Android, in the experimental group; whereas projects in the control group have been developed as Windows-Form applications on Microsoft Visual Studio 2010, using .NET (C#). The course was continued for 5 weeks and it was ensured that projects, learning outputs and weekly course content for both groups are identical, with the only difference in both groups being the educational tool (the programming language) used.

3.2 Data Collection Instruments

Pretest 1: Developed by Osman Ay (Ay, 2011), this is a test that measures knowledge of console-based procedural programming concepts in the C# language, which has an item internal consistency coefficient (Cronbach’s Alpha) of 0,67. Using this test, the knowledge of students in the structured/procedural programming concepts, which they have learned throughout the CS1 course, has been measured and it was made sure that the experimental and control groups are equivalent in this sense.
Prior Programming Experience Form: This form was used in order to gather data from students pertaining to the type of high schools they have graduated from and the context of programming education they have received in high school (if any).
Pretest 2: Developed by the researchers, this test measures knowledge in Object-Oriented GUI Application Development concepts of programming education and has been used to verify the consistency of student declarations in “Prior Programming Experience Form”. The test, which contains 13 items; has an item internal consistency coefficient (Cronbach’s Alpha) of 0,94. As a result of this test, students have been allocated to “Prior experience in GUI-application development” nominal factor groups as experienced/inexperienced.
Post-test: This test has been used to at the end of the research application, for the purpose of comparing academic success of students in experimental and control groups in regards to education on object-oriented GUI-application development. The test, which consists of 20 items, has been implemented as an applied

examination in a computer laboratory. Students in the experimental and control groups have been asked to use relevant tools, with which they have received the CS2 education (MIT App Inventor for the experimental group and Microsoft Visual Studio 2010 for the control group), for answering the test questions. Cronbach's Alpha value for the test, which was developed by the researchers, has been found to be 0,865.

4. FINDINGS

4.1 Testing for Equivalency in Groups

In order to determine whether study groups are equivalent in terms of resuls from Pretest 1 and Pretest 2; it was initially made sure that results from all sub-groups for each test are normally distributed. Following this, an independent samples T-test (p=0,900) for equivalency in Pretest 1, where results are normally distributed; and a Mann-Whitney U test (p = 0,737) for equivalency in Pretest 2, where results are not normally distributed; have been carried out. Both tests have shown that there is no significant difference between experimental and control groups in terms of Pretest 1 and Pretest 2 scores.

4.2 CS2 Success of Groups Depending on the Instructional Tool Used (Hypothesis 1)

The post-test scores of the experimental and control groups have been compared with an independent samples T-test and the results have been given in Table 1. According to statistical test results, average scores in the post-test, which measures object-oriented GUI-application development skills, are significantly different in the experimental and control groups ($t(74)=2,201$, $p<0,05$), with the control group having the higher average. Hypothesis 1 is therefore rejected.

Table 1. T-test results showing difference in score averages between groups depending on the instructional tool used. (Experimental group: MIT App Inventor; Control group: Visual Studio 2010)

Group	N	X	S	df	t	P
Control	34	47,50	25,71	74	2,201	.031
Experimental	42	36,66	17,02			

4.3 Creation of Factor Groups

Students who fall below average in Pretest 1 scores at a range of standard deviation multiplied by 0.3 have been grouped as "unsuccessful", whereas students who fall above average in Pretest 1 scores at a range of standard deviation multiplied by 0.3 have been grouped as "successful" to determine the factor groups for CS1 success

Prior programming experience that students have earned during high-school education has been uncovered with the "prior programming experience form". According to data acquired through this form, it was found that not only did some of the students in the research sample have had programming experience in high school, but also a portion of this experience involved education in object-oriented GUI-application development. Therefore, Pretest 2 has been administered to students in both experimental and control groups to measure knowledge in object-oriented GUI-application development concepts. Students who were below average were allocated into the "inexperienced" and students above average wer allocated into the "experienced" groups for the Factor of Prior High School Education in GUI-App Development. In order to ensure the consistency of this allocation to groups, a chi-square test has been carried out between this nominal grouping and the declarations of students at the prior programming experience form on receiving GUI Application Development course during high school. The chi-square test yielded a result (sd=1, p=0.00) showing the grouping was consistent with student declarations. In this context, the data in Table 2 pertaining to programming education at high school have been gathered.

Table 2. Students' prior programming education from high school

		Type of High School (Received Programming Edu. ?)		Received GUI App Dev. Education?		Was successful in Pretest 2?	
Group	**Total Students**	**Vocational (Yes)**	**Regular (No)**	**Yes**	**No**	**Yes**	**No**
Control	47	38	9	28	10	17	11
Experimental	54	41	13	31	10	23	8
Total	101	79	22	59	20	40	19

4.4 Relationship between Effects of Factors upon CS2 Success (Hypothesis 2)

A 2x2x2 three-way analysis of variance statistical test has been carried out to determine the main factor effects upon CS2 success and the nature of relationships between these effects. The factors that have been taken into account are: a) the instructional tool (BBVPL / SBL), b) success at the CS1 course (Successful/Unsuccessful) and c) High-School Experience in GUI-Application Development (Experienced/inexperienced). The chart detailing tests of between-subject effects for the analysis has given in Table 3. According to analysis results, no three-way interaction between effects of the factors upon CS2 success has been found ($F(1,65) = .440$, $p = .509$). On the other hand, there is a significant two-way relationship between factors of instructional tool and high-school experience in GUI-application development ($F(1,65) = 7,010$, $p = .010$). Additionally, main effects upon CS2 success for each factor, namely the instructional tool ($F(1,65) = 6,349$, $p = .014$), high school experience in GUI-application development ($F(1,65) = 10,435$ $p = .02$) and success at the CS1 course ($F(1,65) = 8,147$ $p = .006$) have been found to be statistically significant.

Table 3. 3-way Analysis of Variance Tests of Between Subject Effects detailing the effects upon CS2 success the factors of instructional tool, CS1 success and high-school experience in GUI-App development

Source of Variance	Sum of Squares	df	Mean Square	F	(p)
Tool	2026,120	1	2026,120	6,349	,014
CS1 Success	2600,003	1	2600,003	8,147	,006
High Sch. Exp. in GUI App Dev.	3330,078	1	3330,078	10,435	,020
TxC	48,951	1	48,951	,153	,697
TxH	2236,920	1	2236,920	7,010	,010
CxH	27,800	1	27,800	,087	,769
TxCxH	140,536	1	140,536	,440	,509
Error	20743,155	65	319,125		
Total	141375,000	73			

4.5 CS2 Success of Novice Students Groups Depending on Instructional Tool Used (Hypothesis 3)

The CS2 post-test scores from subgroups comprised of students who lack high-school experience in GUI-application development and who have been unsuccessful in CS1 –namely, the "novices"- have been compared with an independent samples T-test; the independent variable being the instructional tool used. The results have been given in Table 4. According to the test, there is no significant difference between post-test scores of novice groups depending on the instructional tool used $t(27)=-.977$, $p>.005$. Although, it is interesting that the average scores for novices using BBVPL is relatively higher than novices using SBL

5. DISCUSSION

A review of literature shows that a blocks-based visual programming tool can be used in introductory programming courses (Gestwicki and Ahmad 2011), that doing so may increase student motivation (Wolber 2011) and that while the said tool increases interest in programming in novice students, it may also help maintain the motivation of experienced students (Karakus, Uludag et al. 2012). However, the scenario that has been investigated with this study has yielded results that are partially on the contrary with these claims, showing that as far as academic success is concerned, overall scores of students using a conventional syntax-based language (SBL) for learning object oriented GUI-Application development have been found to be significantly higher than those who learned by using the blocks-based visual programming language (BBVPL). It should be noted that all students in the scenario had previously completed a CS1 course where they were educated in structured programming concepts by using a syntax-based language (C#) for console-application development. This result may show that students who got accustomed to developing applications using a certain programming language/environment had difficulties adapting to a new and radical language/environment. It is believed that it may be useful to investigate the reasons of such a probable problem in adaptation. On the other hand, one reason that may have negatively affected the success of students who used the reference BBVPL, namely the MIT App Inventor for Android, is the fact that the said programming environment is still in a beta development stage, which suggests usability problems. Informal feedback from students received after the research application has finished; revealed that students found App Inventor to be rather slow and problematic compared to an IDE they previously used. Whereas, other issues such as requirement for constant Internet connection, lack of simple features such as copy/paste at components level and various bugs have all led several students to think that working with App Inventor was a “waste of time”. In his study, Bhagi had also underlined several shortcomings of the App Inventor platform in terms of mobile game development (Bhagi 2012). It should therefore always be kept in mind in further research that MIT App Inventor is still indeed at beta development stage.

Another research finding indicates that; in addition to the programming language of choice, prior success in a structured programming undergraduate course (CS1), and high-school experience in object-oriented GUI application development are all factors that have significant main-effects upon object oriented GUI application development (CS2) success at undergraduate level. This result complies with studies in the current literature which claim that high school programming education positively effects success in undergraduate programming education (Hagan and Markham 2000, Wilson and Shrock 2001, Holden and Weeden 2003) and studies that claim existing knowledge in structured/procedural programming approaches positively effect success in object-oriented programming education (Sharp and Griffyth 1999). A two way interaction exists between effects upon CS2 success of ,the programming language of choice and high-school experience in object-oriented GUI application development. While students with high-school experience in GUI-app development do better in CS2 using the SBL; those without high-school experience do better in CS2 using the BBVPL. This clearly shows that, the effect of the instructional tool (programming language of choice) upon students’ CS2 success is influenced by long term (high school) experience; which brings an explanation to the result observed at the testing of Hypothesis 1. In that, the fact that CS2 success among the experimental and control groups seems to be higher in the control group who used the SBL, may be specifically due to students in possession of long-term, high school experience in GUI-app development have failed to adapt to the use of BBVPL.

From factors that impact CS2 success, the lack of significant relationship between success in the previous undergraduate CS1 course, which involved education in structured programming concepts, and high-school experience in object-oriented GUI-application development; could be associated with the content of the object-oriented GUI application development courses received by students during high-school. At this point, it could be possible that the vocational high schools that taught object-oriented GUI application development may have followed an objects-first approach in teaching programming to their novice students; which may have resulted in the students being captivated with the graphics nature of applications and failing to improve their more basic and abstract programming skills associated with structured programming, namely, simple algorithm development, working with conditionals, loops, etc. This is supported by several studies in the literature stating that as programming education shifts from procedural to visual and object-oriented, students’ skills in algorithm development and code generation get weaker and their academic success therefore drops (Beaubouef and Mason 2005, Reges 2006).

The fact that there is no role of the CS1 success factor in the impact of programming language of choice upon CS2 success, clearly shows how important a CS1 course that prioritizes teaching structured programming concepts is for programming education. Since, it can be inferred that, students who have been successful at a course that encompasses structured programming concepts (CS1) are prone to be successful in an object-oriented GUI-application development course (CS2) regardless of which programming language is used as an instructional medium. It can be said that, no matter how GUI-application development is found to be more interesting and relevant to real-world by students; a structured programming course dealing with more abstract concepts as a first-step in programming education could be more viable.

The research also showed that, the so-called “novice” students, who did not have prior programming experience from high school and who were found to be relatively unsuccessful at the structured programming education with a syntax-based language at the CS1 course; have done better in CS2 using the BBVPL (MIT App Inventor for Android) than using the SBL, although the difference was not statistically significant. MIT App Inventor for Android therefore still has a potential to be used as a tool for introducing novices to programming or reclaiming students who perhaps failed to adjust themselves to programming due to abstraction concerns or difficulties in coding and syntax-use. This result complies with studies in the literature that claim MIT App Inventor could be a useful tool for introducing novices to programming (Spertus, Chang et al. 2010, Uludag, Karakus et al. 2011).

6. CONCLUSION

Although it is claimed by researchers that developing applications for use on smart mobile devices could positively influence academic success in programming courses due to an increase in student motivation; it is suggested by this research that this claim can be influenced by various factors. It is also suggested that success in a previous course that teaches structured programming concepts (CS1) is an important factor in achieving success in an object-oriented GUI application development course (CS2), to the point that; even if the IDE and programming language used in CS1 is changed at CS2. With the motivation effect it brings about and the blocks-based concept, MIT App Inventor may have a potential to be used as a tool for introducing novices -who have no prior experience in the field- to computer programming. Additionally, it can also be used for reclaiming students who could not adjust to conventional syntax-based programming education. On the other hand, students who possess a long-term experience in object-oriented GUI-application development –possibly acquired at a vocational high school- prefer to continue education in the syntax-based language for developing applications targeting the desktop PC-that which they are accustomed to-, rather than in MIT App Inventor. One reason for this, could be the the usability concerns involving MIT App Inventor, which is still at a beta development stage.

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SHIFTING CONTEXTS: INVESTIGATING THE ROLE OF CONTEXT IN THE USE OF UBIQUITOUS COMPUTING FOR DESIGN-BASED LEARNING

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ABSTRACT

In design teaching ubiquitous technologies can offer new ways of situating learning within real world experiences. Yet they require new types of knowledge; both an understanding of how to work with the technology and also an understanding of how to use the technologies to respond to changing contexts such as the place and the people. We sought to understand the factors affecting how students work with the acquiring these broader knowledge bases and how this impacted on the learning outcomes in design-based learning. In this paper we discuss an approach to tertiary design teaching that involves the use of ubiquitous technologies to support fieldwork and in-situ learning and through this we evaluate the impact on teaching and learning. We will describe the methods of the study, which involved pre- and post-interviews and questionnaires completed by individual students, focus groups as well as analysis of the outcomes of the student projects. We will explore how a series of different contexts framed and affected the learning experience by exploring the context as location, technology and social setting. Since the projects required students to not only use ubiquitous technologies as tools for learning, but also as components of the design project outcomes we also highlight a series of short case studies of student project outcomes to analyse how the students integrated them into their learning environments. In the discussion of the results we will focus on how the context of the learning was understood by the students, and we will discuss an evaluation of how this changed during the course of the teaching project.

KEYWORDS

Ubiquitous, learning, situated, technology, context, site, space

1. INTRODUCTION

Ubiquitous computing extends digital media out into the physical world – whether this be the university campus, city parks and streets or through global connections to location-based data. As well as moving with the user, sensors embedded within the environment capture information about their current context, including their location, and this is used to deliver them an experience that changes according to where they are, what they are doing, and maybe even how they are feeling. In the use of such technologies interaction is shifted to mobile displays that travel with the user, bringing multiple and shifting backdrops for screen-based activities. The interaction becomes situated with everyday world activities and experiences, and the ‘context’ of the interaction becomes a critical facet of how the interaction develops.

Ubiquitous technologies are typically defined as wireless, mobile, networked and embedded in the physical environment (Weiser 1991), enabling everything and everyone to be connected. This research focuses on the use of a particular range of ubiquitous technologies; augmented reality, smart objects (Internet of Things) and locative media. The aim was to evaluate the value of working with ‘real world’ scenarios to enable new learning opportunities within the context of design based tertiary teaching (in particular Interaction design and Architecture). We explore a teaching approach that enables the student to move away from the screen into the physical world, that supports in-situ learning design activities that can have significant benefits for learners (Benford 2005, Rogers et al. 2002). Through enabling new ways of working in real-world settings these teaching activities aim to offer an embedded and innovative enquiry-based approach to the delivery of teaching in the two disciplines.

Mobile learning presents learners with a variety of contexts where they can learn and experiment in real-world situations. By mobile learning we refer to 'any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies' (O'Malley et al. 2003, 6). The premise of this approach to situated learning is that if a learner can align their learning with actual situations, scenarios, and environments, basic concepts and vocabulary are clearer and easier to remember and transfer (Gee, 2008). When learning shifts from traditional frameworks and settings then one of the key characteristics of what shapes this learning is the 'context' of the learner. According to Dey's commonly accepted definition 'context is any information that can be used to characterise the situation of an entity. An entity can be a person, a place or an object that is considered relevant to the interaction between a user and an application' (2001, 5). Arising out of this, many definitions and surveys of context have been presented such as Dix et al. (2000) and Chen and Kotz (2000). Yet defining and working with the context of the learning experience is challenging. The important aspect is that 'context is not an outer container or shell inside of which people behave inside of which people behave in certain ways. People consciously and deliberately generate contexts (activities) in part through their own objects; hence context is not just 'out there'' (Nardi 1992, 38).

In this paper we aim to establish a clearer understanding of how different contexts shape mobile learning and what lessons we can learn about how support design teaching. This is done from the perspective of the design disciplines where the 'context' is a core concept in how student projects are structured and developed. Ubiquitous technologies and tools demand the development of new trans-disciplinary paradigms, strategies and protocols for users (designers, engineers, architects and artists) and require that the sites, agents, provocateurs, disparate observers and drifters that consume and influence their output critically engage with them. As highlighted in the NMC Horizon report, that addresses future developments of technology in tertiary education, a clear agenda is outlined where students need to develop skillsets in working with 'physical' mobile and 'ubiquitous' or 'pervasive' computing projects that require the development of physical, haptic, object/device, installation/environment based systems (NMC Report, 2011). In design teaching this is a particular challenge, as traditional spatial design skills are increasingly requiring an understanding of digital interaction as integral to the design outcome. This challenges the scope of existing design teaching, and according to Stenton et al. 'the merging of virtual content with physical space extends the boundaries of classic human–computer interaction…..We need to establish a new set of design guidelines and interaction styles. This requires new skills to evolve' (102).

In this paper we discuss an approach to design teaching that involves the use of ubiquitous technologies to support situated learning and exploration and through this to evaluate the impact on design teaching and learning of a range of ubiquitous technologies. We propose that, in learning settings that deal with the design of both spaces and objects as well as digital media interactions, it is critical to challenge students to learn how to embed technologies that operate as interfaces to interactive physical, and augmented reality environments. We ran a series of interdisciplinary collaborative design-based teaching activities between undergraduate Architecture and Digital Art and Technology (DAT) students at Plymouth University and used ubiquitous computing to deliver in-situ learning for design activities. The aim was to understand the impact on teaching and learning of ubiquitous technologies[1] (Johnson & Adams, 2011) in order to evaluate the potential of new learning opportunities.

2. METHODS

We used primarily qualitative methods to document and evaluate the benefits of ubiquitous technology as both teaching tools and also materials for design projects. These included pre-, during and post- evaluation using qualitative methods including observation, focus groups, cultural probes and post project interviews and questionnaires. We monitored and evaluated how the students used specific ubiquitous technologies to develop their project.

[1] Ubiquitous technologies are typically wireless, mobile, networked and embedded in the physical environment (Weiser 1991). These include mobile and smart phones, GPS or satnav devices, sensors and RFID or 'smart objects'.

2.1 Design Workshops

We designed, ran and evaluated two three-week teaching workshops with an interdisciplinary group of undergraduate design students. The teaching workshops were run design students from two courses in; Architecture and Digital Art and Technology (DAT). By mixing the groups from different disciplines we sought to challenge them to draw on their different, but complimentary, knowledge and skillsets of how to work with the spatial aspects of the project (architecture students) an the technological aspects (DAT students). They were three weeks in duration and the outcomes were assessed and contributed to a percentage (10%-20%) of the students' final year mark.

The activities included:

1) Design and running of a series of collaborative design workshops (three week duration) which incorporated ubiquitous computing prototyping tasks enabling us to identify factors influencing the quality of students' learning (see 2.1 below for further information). Students were given a brief, a site (location) for the project and asked to work with a set of ubiquitous technologies.

2) Documentation of student learning experience using qualitative methods including: observation of how students work as 'producers', 'Think-aloud' method for students during specific tasks, student reflective 'journals' documenting progress through each workshop and visual recording of student project outcomes in-situ.

3) Post -Evaluation through interviews and focus groups of the appropriateness and benefits of technologies as teaching materials and resources –including triangulation of outcomes from documented qualitative data from all two project workshops. These were a series of thirty-minute to one hour semi-structured interviews with students at the end of the project.

2.1.1 Briefs

We situated the learning within an authentic context. This included real spatial, social and technological challenges and also set up a series of engagement activities where the students interacted and collaborated with people in the context of the project. By doing this we established the project within the framework of situated learning in that we allowed for the fact that knowledge needs to be presented in an authentic context, i.e., settings and applications that would normally involve that knowledge and 'learning requires social interaction and collaboration' (Lave and Wenger 1990). Therefore the two workshop projects had live site-specific briefs, where the students were required not just to engage with the location (the site), a set of technologies but also with people (local communities). The first of the two projects required students to explore the potential of Internet of Things (IoT) technologies and applications for the design of an outdoor leaning space at a local school in Plymouth, UK. The projects took place in October (Project 1) and November 2013 (Project 2):

Project 1: The project had a live (real) component that included the brief to design a participatory intervention in collaboration with a local school (Devonport High School for Boys, Plymouth, UK), and a group of year eleven-twelve year old pupils at the school. Students were asked to incorporate a range of ubiquitous technologies that would support learning into the design, as well as to respond the particular physical characteristics of the physical site and the learning context of the school and its students. The groups of six (three students each from Architecture and DAT courses) students ran a series of participatory workshops at the school using iPads and QR codes (with the Tales of Things[2] application) to gather student feedback and used social media to report outcomes. The culmination of the project was a large workshop showcase of the projects to the school, which was attended by approx. thirty school pupils, five teachers and representatives from local organisations such as the arts officer from the local City Council.

Project 2: The second stage of the project required the students to explore the potential of Augmented Reality applications such as Layar, Arduino and embedded sensors. Students were briefed to design a future archive for a local neighbourhood in St Blaise, Cornwall, UK. They were given a specific setting or site to work with and were required to draw on input from local people and locally available information to inform the project development. The outcomes were presented to the local community as part of a participatory exhibition in the local community centre.

[2] www.talesofthings.com

2.1.2 Participants

There were forty-eight students in total – thirty from the Architecture course and thirty from the DAT course. All students were either in their second or third year of undergraduate study. The students had not previously worked together at the start of the project and were put into groups with equal number of students from both courses. There were eight groups. The groups remained the same for the second project. All students participated in the design workshops, and completed pre- and post- questionnaires. Fifteen students participated in the post evaluation focus groups and interviews.

2.1.3 Materials

Students were required to work with a range of ubiquitous technologies; including QR codes, networked sensors, AR applications (Layar), Arduino, RFID and GPS applications. They were given access to an iPad per group for the duration of the project, as well as a small pool of iPhones, Android tablets and Arduino kit.

2.1.4 Setting

Both projects were set in actual locations; the first being the grounds of a local school (Devonport High School for Boys, Plymouth, UK). The second was a site in a small town; St Blaise in Cornwall. All students visited the sites on at least two occasions.

3. RESULTS

The key quality of using ubiquitous technologies for learning is that they allow the learning environment to move beyond the traditional teaching environment and into the real-world context. Yet we found a diverse range of ways in which students understood how the context affected the learning experience and setting. A core concept was that of what the students considered as the ‘site’ for the projects in the workshops. We asked students to describe how they understood concepts such as ‘site’ and ‘ubiquitous computing’, since these both played a role in contextualising the learning task. In the outcomes of the interviews with the students we found that students changed the way they understood context as a result of the project. We also observed key differences in how students from different teaching backgrounds understood theses key terms. Typically the Digital Art and Technology (DAT) students saw the ‘site’ initially as the technological site, such as a website or a set of location-based information, whereas the architects saw it as ‘building’ site or a spatial extent with a boundary. This emerged clearly in the pre and post questionnaires- see below. But in the interviews we saw more nuanced understandings of how the ‘context’ affected the way the students constructed and related to the learning task, and how they responded to it.

We explore the different concept of context that emerged during the running of the project and its evaluation. We consider how the students understood and learnt about the context as a location, the context as a range of technologies and the context as a social setting.

3.1 Context as a Location

In the pre and post workshop questionnaire we asked students to reflect on a series of questions. We also asked the students to document their everyday use and exposure to a range of media and ubiquitous technologies to gain an understanding of their personal context of how they might be using these technologies as part of background leaning. Below are some sample answers for how they responded to the prompt: “How would you define a site” (see Table 1). In the table the words highlighted in bold refer to the concepts, in terms of how they were understood by the students prior to the workshops and then post workshop. By comparing the change in language between the student’s description pre and post workshop we can see a shift in their understanding of location or ‘site’:

Table 1. Pre and Post workshop responses to question - "How would you define a site"? (References to location pre and post workshop are highlighted bold to indicate the shift in the way that 'site' in understood by the students.)

Student	Pre workshop.	Post workshop.
Karlie A. (DAT)	Presuming we're not talking about websites, I would define a site as a physical area or a **location** within which an event takes place or a point of interest (for whatever reason) is.	A site is a place, location, area that has a designation for a means of development, reshaping or production. It is at it's roots a **physical space with the potential** for non-physical integration/use, but until utilised remains merely a space of potential.
Chris T. (DAT)	A site is a **specific area** that has been designated by someone for a specific purpose. For example, a building site. This would have been chosen for a number of criteria and for the sole purpose to build upon.	A site, is a specific space in which a selected user has located in order to **create**, construct, demolish or destroy an idea.
Lewis P. (DAT)	A **point or an area** on the Earth's surface or elsewhere.	A **location/place** used for artistic/technological/archaeological practice.
Shakurakh B. (Architecture)	A **specific location** which is of significance. Can be a location for something (a purpose) or a location that served a purpose in the past. Chosen area.	A **location where people's activities and feelings** are manifested.
Sam M. (Architecture)	**Defined** by a boundary, intention and a marking. A space where an area is defined, there is a mark and people are involved	**People**. Boundary. A mark – 'Land' mark.
Alex G. (Architecture)	A site is **a situation** whether that be physical or immaterial, that can be engaged with through the senses	The **area of influence** surrounding a specific point.

The student's responses indicate a broadening of the understanding of how the characteristics of the location affected interactions, and that a site had an 'affect'. The responses pre workshop tended to describe a site as having a specific purpose or of being bounded. The post workshop responses broadened out the understanding of site as one having potential, influence or a manifestation of feelings and activities. In the interview one student commented the impact of engaging with the site:

"*I like going to the site rather than looking at a computer screen you don't really get a feeling for it, You need to learn about the area, understand the area, understand the people to really get a sense of what needs are going on. So much goes on in that one space you get a sense of that space, its not just a visual thing, you have to be there to experience that, and at different times of day now that might effect it*" (Alex G.)

This also encompassed the idea that a site was not a distinct location, but also could relate to multiple or overlapping real and virtual spaces. According to one student '*for instance I would have defined space as something we inhabit physically, and populate inside a physical realm, whereas I found that space could also mean a virtual space, or a space that kind of transcends a location not necessarily one fixed location"* (Miguel F.)

This was in contrast to the pre- workshop interviews which, although divergent, tended to use terms such as 'specific', 'defined' or 'used' which suggested much less potential for the site to be transformed through interaction. In the interviews we uncovered a widening of the understanding of the scope of the project as students began to be aware of the potential of the site to be a source of inspiration. For instance one student commented:

"*It was cool to work in a set space or site. It almost felt like you had more scope. Instead of working on this, we are working on this [hand gestures of larger proportions] sort of big spaces and yeah I liked it, it seemed to make the projects bigger. I guess they were bigger projects to what we were used to*." (Paul W.).

Over the course of the project it appeared that students literally became aware of the multiple potentials of the site to inform how they learnt; the learning context literally expanded and became a 'bigger space'.

3.2 Context as Ubiquitous Computing

The range of IoT and Augmented Reality technologies were perceived by the students as expanding the scope of the learning experience. A general outcome was that the technologies created a dynamic level of interaction. For instance one student commented that: "*I learnt how digital media can be used to interact with architecture and how it brings it to life*". We also asked for students to outline how they might describe how they understood the term 'ubiquitous computing" (see Table 2). The students generally refined and developed their understanding of the term through the experience of the teaching project. But there was also a sharp distinction between DAT students (who were familiar with working with a range of technologies as part of their course, and also used them in their everyday lives more extensively and frequently) and architecture students (who typically had little exposure to these technologies and also used them in their everyday lives less extensively and frequently). In the table the words highlighted in bold refer to concepts as they were understood by the students prior to the workshops and then post workshops. By comparing the change in language between the student's description pre and post workshop we can see a shift in their understanding of ubiquitous computing:

Table 2. Pre and Post workshop responses to question - "What is your understanding of the term 'ubiquitous computing"? (References to ubiquitous computing pre and post workshop are highlighted bold to indicate the shift in the way that 'ubiquitous computing' in understood by the students.)

Student Name	Pre workshop.	Post workshop.
Phillip R. (DAT)	Ubiquitous computing means **ways of interacting** with a computer in ways other than with a standard desktop. An example might be a SatNav system.	**Technology embedded into objects**, making them part of the internet of things.
Christopher P. (DAT)	Ubiquitous computing is **combining technology** into everyday objects that give or receive data, and use this data to change the environment around them.	Using **computers/technology on/in everyday objects** to make them interact with each other or users to give us information they we may not otherwise be able to attain.
Alex G. (architecture)	Ubiquitous computing is **computing in the everyday**. This could be a bin that identifies rubbish and sorts it for you, and then connects to the internet framework keeping /collecting data on it.	**Integrated intelligence** in design.
Katrina N. (architecture)	The ability to **access computers everywhere** e.g. smartphones	Being able to **communicate with each other through technology** and using technology to change attitudes and create a fun and educating experience.
Alex M. (architecture)	**Access to internet everywhere** e.g cloud	**Computing integrated into everyday devices**, help people communicate, connect and improve productivity

The shift in understanding that emerged across the student group was from technology as 'access' or embedded within the world to that which was integrated and communicating with objects and spaces. This changed the application of ubiquitous computing, from that which passively sensed and collected data (such as a 'smart bin'), to that which facilitated interaction and was somehow seamlessly interwoven with everyday experiences. There appeared to be less of a distinction between computing as data accessed through a device to new models of communication and interaction that would similarly 'affect' everyday scenarios. In the interviews the students also described how they changed their understanding of the potentials of ubiquitous computing through a sense of occupying. One student commented that '*I learnt how technology can change a way that people interact within a space*".

Interestingly one of the issues that arose as a result of working outside of traditional teaching settings was the degree to which the learning context could not be controlled or which remained constant. Some students commented on how aspects such as the weather, and the fact that travel was involved to get to the site of the project, impacted on the learning experience. For instance a DAT student commented:

"*We spent a lot of time going to the site, during the first project. I went down there a couple of times. And the first one was horrendous, it was peeing down (sic.). Not just on that day, the weather had been going on* *for ages and I was fed up of it. We were trying to, to use the QR code stickers to stick on… brilliant, they don't work in the rain*" (Paul W. DAT).

This highlights the fact that working with live contexts is seen as fundamentally different to working within traditional learning settings. In the process of situating the learning within a realistic context this introduced a lack of control of the setting; it rained, it involved travel, local people did not understand how to use a QR code etc. But the use of ubiquitous computing and real contexts meant that the student was required to confront and respond to conditions that would in fact have a significant positive effect on the learning outcomes. This potentially means that the learning value of the project has been raised, as students are challenged to work within contexts that require them to extend their skills and understanding.

3.3 Context as a Social Setting

The other important context that emerged as a result of working on a live project was that the students were working with people outside of the university learning environment. It became clear towards the end of the project how much the students valued having input from the social setting of the project site. For instance one student commented "*It was very interesting hearing how this could effect members of the public*". Whereas another described how:

"*I had to work out a way of adding digital value to a physical space, this involved mostly thinking about how people use the space, then thinking of ways that this could be changed and hopefully improved*." (Lizzie S.)

The fact that the ubiquitous computing also enabled and encouraged people to engage with the projects and 'affect' the outcomes again expanded the scope of what they had conceived as possible, and to understand the actual context of use. A student explained that:

"*They seemed like more rounded projects, they seemed like more useful projects, actually going to be used. In theory they could have been used. I think it added more of a real world component to it, instead of just us being insulated; we were working with other people*" (Paul W.)

4. DISCUSSION: MEANINGFUL LEARNING OUTCOMES

According to O'Malley et al.'s definition mobile learning is where 'the learner takes advantage of the learning opportunities offered by mobile technologies' (2003). In this study we found that the learning opportunities arose out of students exploring the potential of ubiquitous technologies as part of an authentic social and spatial context. The situated nature of learning meant that they widened their understanding of what was 'affecting' the development of their response to the brief given to them. As they engaged with the actual place, had hands-on experience of the technologies they were designing for and also interacted and collaborated with the people they were designing for the context of the design project moved from being abstract to meaningful. For example students' responses in questionnaires about the meaning of the word 'ubiquitous technology' shifted from an abstract concept of 'computing everywhere' to that of an 'integrated' or 'embedded' technology. Collela hypotheses that these types of projects 'reconnect abstractions with embodied, physical, spatial explorations that precede concrete sign systems. This may make the learners' experience of abstract concepts yet more visceral and meaningful (2000). Through this process the understanding of the dimensions of the project became broader, and also more meaningful or 'affective'. So for example the students' understanding of the concept of 'site' shifted from 'location' to a 'physical space with potential' (Karlie A.) and students reported in the interviews that the site simply 'seemed bigger' (Paul W.).

In the following section we describe a series of example outcomes from the design projects and discuss how the learning context became more meaningful due to a broader understanding of the context:

4.1 Project Outcome One: Memory Shadows

In this project titled Memory Shadows the students design proposal involved embedded ubiquitous technology in a physical setting to enable a rich context. The project proposal consisted of a QR code interface embedded in the location and linked to a series of verbal memories collected from local people related to their experience of the place from when they were young until the present day (see Figure 1.). These invisible and private stories were brought to light and public by means of QR code technology. When scanned, using a QR reader, like a smart phone, you could hear actual audio recordings of the people that lived there. The students were able to connect the story, the people and the site and convey an understanding of the rich social, historical and cultural presence that the location represents.

Figure 1. L-R: Students' testing the use of QR codes to record and display contextual information in the setting, concept of memory shadows interface, and visualization of project in the setting.

The use of Internet of Things (IoT) technology became a way to embed historical information at the site that could be accessed through the use of an everyday mobile interface. Rogers et al. found in the Ambient Wood project 'one of the most successful forms of digital augmentation was the combination of the probing tool and the interactive visualization display' (2005), similarly in the project the students' use of ubiquitous technology to 'augment' and link digital information with hidden social information embedded in a specific physical place resulted in a richer social, spatial and technological project.

4.2 Project Outcome Two: Voting Wall

This project embeds a polling system for the community in a wall located in the centre of the small town. Through the ubiquitous technology incorporated in the wall the citizens of St Blazey would be able to vote on matter concerning the whole community. The wall consists of LED lights, controlled through an Arduino system, that could also play back a time-lapse visualisation of previous vote (see Figure 2). The voting wall connects the community and, through lighting visualisation, transforms the hidden space of decision making into an external shared space that bring the outside inside and vice versa.

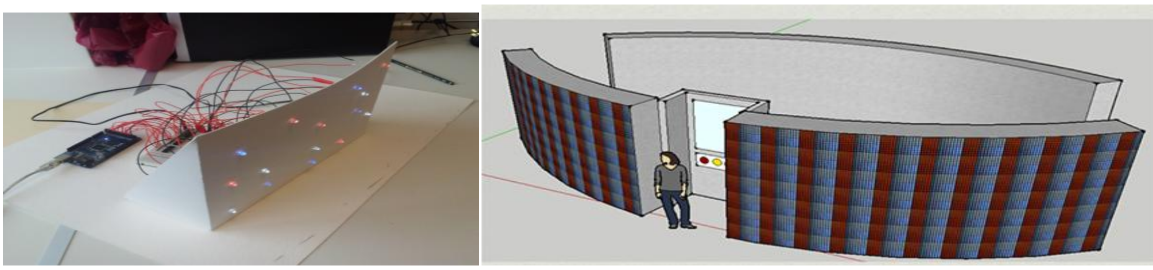

Figure 2. L-R: prototype of interactive lighting technology (Arduino Mega board and LED's), visualization of design proposal.

Rather than working with a fixed or defined set of people in mind, this project expanded to accommodate the aspirations of a small town and how their collective decisions could change both the people and the place. To highlight the comment of one student, they understood how the project "*could effect members of the public*" (Paul W.). In this project, the social context is inscribed and embedded into the physical element of the space, so that the use of the place is redefined by the socio-technological system.

4.3 Project Outcome Three: Sixth Sense

The second project extended the idea of place, from a singular physical setting (an external learning space in the grounds of a school) to a much wider understanding of the location that encompassed not only the grounds, but the whole school and its pupils. The project proposed an environmental sensing system that was to be embedded throughout the school and which would deliver live information about energy use to an external learning space (see Figure 3.) designed to raise awareness and responsibility at towards their use of energy. By means of sensors (temperature and light) and microprocessors (Arduino) embedded into the School buildings, the system measured heat and light values and displayed this data in real-time within the external learning space in the form of an experiential visualization (see Figure 3.). The use of ubiquitous technologies such as Arduino linked into a web-based user interface enabled a key shift in the thinking of the 'site' the school had suggested for the project. The technology enabled the site to extend to the whole school, so that it became embedded in a series of classrooms, involved interaction with school students and teachers and networked with the external space.

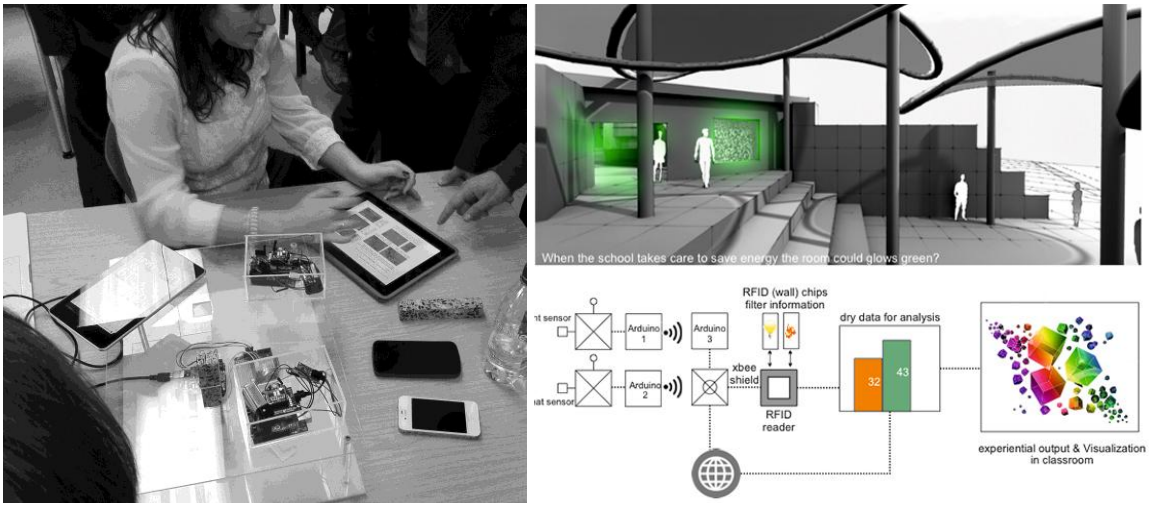

Figure 3. L-R: Sixth Sense prototype of environmental sensing interface (at school showcase event), visualization of space (above) and technical architecture (below).

The key factor that students identified was not simply the potential of visualizing change in the school environment as information, but also how creating an awareness of energy use linked to a particular place could also shape behaviour. As one student commented '*I learnt how technology can change a way that people interact within a space*", so the project facilitated a more dynamic understanding of the school as both a physical (energy using) site and a cast of human actors (staff and pupils), where the technology could become a tool to mediate this ensemble.

5. CONCLUSION

When learning shifts from traditional settings then one of the key characteristics of what shapes this learning is the 'context' of the learner. Yet defining and working with the context of the learning experience is challenging, as it inherently changeful and subjective. In this paper we discussed an approach to tertiary design teaching that involves the use of ubiquitous technologies to support fieldwork and in-situ learning and exploration and through this to evaluate the impact on teaching and learning of a range of ubiquitous technologies. We evaluated the outcomes for learners through a series of pre- and post- interviews and questionnaires as well as observation. In particular we explored how the context of the learning task was understood and explored by the students not just as a tool for design but also to design with. We found that the use of ubiquitous technologies within the context of a 'site' extended the students initial understanding of the site as a specific or defined location, to a broader and more 'affective' concept of the site. A similar broadening of the scope of the project developed out of the exploration of ubiquitous technologies and they saw these less as technologies to be accessed or used, and became more aware of the integrated nature of technology and space. Generally the benefits of using ubiquitous technologies were grounded in the fact that they took the learning space out of a contained and constrained teaching environment and exposed the learner to shifting spatial, technological and social contexts. As Nardi highlights the context was not just 'out there', it was meaningful and had definition. We believe that this type of learning experience, delivered though an embedded and situated learning approach using ubiquitous technologies, can inform meaningful outcomes in design based teaching and assist in the development of a more contextual and innovative learning experience.

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EVALUATION FRAMEWORK FOR DEPENDABLE MOBILE LEARNING SCENARIOS

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ABSTRACT

The goal of the dependability analysis is to predict inconsistencies and to reveal ambiguities and incompleteness in the designed learning scenario. Evaluation, in traditional learning design, is generally planned after the execution of the scenario. In mobile learning, this stage becomes too difficult and expensive to apply due to the complexity and heterogeneity of mobile infrastructure with contextual constraints. In other word, the test of the dependability has to be alone at early stage. To achieve our goal, evaluating the dependability of the learning scenario, the evaluation model is constructed from the analysis of literature by exploring different aspects of dependability. We propose to apply formal specification and verification in order to evaluate the functional dependability of the mobile learning environment. A specification is the description (usually by means of a temporal logic formulas) of the property (or temporal behaviour) to be fulfilled by the environment under consideration. Verification consists on (exhaustively) proving that the learning environment is correct.

KEYWORDS

Mobile learning, evaluation, formal specification and verification, learning scenario

1. INTRODUCTION

Dependability is an important pre-requisite for mobile learning (Magal-Royo, T. et al, 2007) and should be evaluated sufficiently and at early stage to respond user's requirement. In fact, the learning environment had to operate as learners and designers expect and that it will not fail in normal use (Lê, Q. and Lê, T, 2007).

Many researchers have defined the dependability in slightly different way. Dependability is an orthogonal issue that depends on QoS. We consider its original meaning as defined in (Laprie, J.-C, 1985), (Avizienis, A. et al. 2004) : "*Dependability is the quality of the delivered such that reliance can justifiably be placed on this service*". It could be typically divided into a number of aspects namely (Avizienis, A. et al. 2004): (functional) correctness, safety, security, reliability, availability, transparency and traceability. Each dimension includes analysis techniques, assessment methods and measures. Mobile learning environments come with requirements from all aspects of dependability. The reason for this lies in the nature of these mobile scenarios itself. Typically these environments are very tightly connected with specific users.

Dependability evaluation is an important activity as well as evaluation of the executed learning scenario. Post-evaluation techniques and approaches take much time and cost, and an early preventive evaluation could be one of the key factors to cost effective mobile learning development.

The basic question is: *How to evaluate the learning functionalities in their context of use at early stage in order to ensure the dependability of the conceived scenario*?

To answer to this question, we first summarize our definitions. We define learning scenario as technological environment consisting of one or more activities, correlated together offering a complete scenario of information and communication services required for supporting learning. A mobile learning can be defined as "*… any service or facility that supplies a learner with general electronic information and educational content that aids in acquisition of knowledge regardless location and time…*" (Lehner, F. and Nosekabel, H. 2002.).

This paper proposes an early preventive evaluation framework: ReStart-Me (**R**e-engineering **e**ducational **S**cenario based on **t**imed **a**utomata and t**r**acks **t**reatment for **M**alleable learning **e**nvironment) that intends to reduce the time and cost through using test cases as a means of the evaluation. Test cases are developed in the process of the leaning scenario design and used to test the target scenario. ReStart-Me checks formally inclusion relation between dependability requirements and test cases.

2. BACKGROUND AND RELEATED WORKS

2.1 What can we evaluate in Mobile Learning Scenario?

As computers have become more rapid and powerful, educational software has flourished and there are numerous claims conceived by designers. Thus evaluation software is important so that teachers can make an appropriate choice of learning scenarios and which are suitable to the teaching and learning context.

According to (Elissavet, G. and Economides, A. A. 2003) we can evaluate these following dimensions in a learning scenario: content, technical support, learning process (see figure 1). Each dimension includes a number of sub categories and criteria that could be considered in the evaluation process. All these aspects are equally important, as the learning activity has to be simultaneously pedagogically and technically sound.

However, we propose that the learning activity's context should also be considered for evaluation. The context is a set of evolutive elements appropriate to the interaction between learner and learning application including the learner and the learning environment themselves. Figure 1 presents in a diagram the different aspects that we can combine and include in the evaluation framework.

Mobile learning could be evaluated from different viewpoints: The first one is a technical oriented perspective. The content suitable for m-learning needs to be available and adequate to the learning environment. The second one is pedagogical oriented perspective. It points out that m-learning develops new skills and approaches to ensure the pedagogical effectiveness. We consider that the context of mobile environment should be also considered in evaluation process. The features of activity's context are: location, network, user, time and device.

- **<u>The device dimension:</u>** we consider that it is important capabilities of user's device, especially hardware attributes, for mobile learning due to the fact they have a big impact on learning scenario execution.
- **<u>The network and connectivity dimension:</u>** nowadays mobile device might be connected to the "Net" via many technologies: GPRS, UMTS, WiFi, 3G-telecommunication, etc. Mobile devices often have periods of disconnection that had to be considered in evaluation of the dependability of the learning scenario. The connectivity quality depends on user's location and mobility.

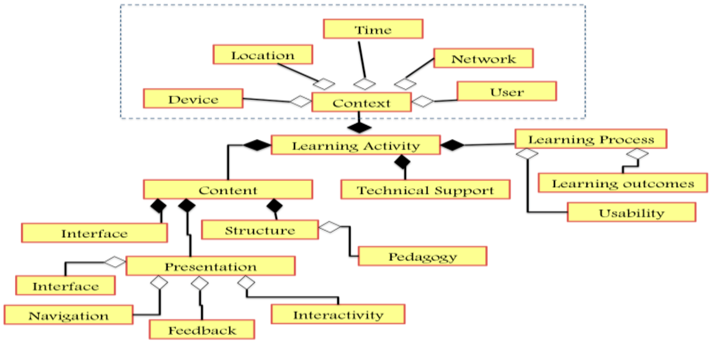

Figure 1. Different features that could be evaluate in the learning scenario

2.2 Evaluation of Mobile Learning Scenarios: Related Works and Issues

There have been several researches to develop methods to evaluate mobile learning scenario. The most widely used methods are:

- Heuristic evaluation method based on principals and many categorised dimensions (Nielsen, J. and Molich, R. 1990). A wide range of methods has been developed to systematically evaluate the quality of information technologies.
- Evaluation methods based on Simulations (Polson, L. C. et al. 1990) where some user problems are simulated in details, especially analysing each task from a cognitive point of view.
- Evaluation system based on tracks analysis requests both analytical and technical staff. The first group is responsible for defining scores for various features of the e learning scenario according to a specific set of evaluation coefficients. This team also specify the quality of the learning scenario. The technical staff develops the system or specify the evaluation framework to the mentioned scores (Zorrilla, M. and Álvarez, E. 2008) (Ben Sassi, M. and Laroussi, M. 2012).
- Teaching test methods are based on an appropriate testing program that is suitable to different goals and characteristics of the teaching style. These methods implement the pre-test, the post-test of the learning scenario, and other steps to test the knowledge of students and their skills and finally determine the effectiveness of teaching scenario (JIAa, Z. and Han, X. 2013).

As shown, there are several evaluation studies. However, these methods vary widely in their evaluation scope, outcomes and techniques. In fact, in the one hand, there are generic methods that, although useful in theory, are not very applicable in practice, since they do not take into account the situatedness of the courseware evaluation, determined by the context of the learning scenario. In the other hand, some of these methods described above have a very specific target (cognitive overview). Nevertheless, with the growth in the use of mobile technologies and the learning scenario database, an increasing number of teachers want to reuse their scenario in different contexts.

Instead of adding to the already large number of checklists for learning scenario evaluation, we are attempting, in the following section, to address contextual evaluation based on formal modeling and verification of educational scenario. Next, the evaluation framework is discussed.

3. RESTART-ME: A FORMAL EVALUATION FRAMEWORK FOR M-LEARNING

3.1 Restart-Me Challenges

In order to fill the gap between learning scenarios evaluation methods and mobile learning scenarios, we present in this paper, a formal method to evaluate scenarios at an early stage: ReStart-Me (Re-engineering educational Scenario based on timed automata and tracks treatment for Malleable learning environment). This formal evaluation is based on automata theory and formal verification and aims to:

- Avoid costly and time-consuming scenarios implementation or deployment
- Simulate scenario execution on real time in order to check properties and to detect errors (such as deadlocks and liveness) and then to regulate scenario with timing constraints.

The evaluation framework is based on different kind of context: Actors, Location, Device, Network and connectivity. These elements are motivated by an empirical analysis of different definitions of learning context. In fact, these elements represent core features of any educational scenario supporting any learning approaches such as hybrid learning, mobile learning, ubiquitous learning, pervasive learning,... Consequently, they represent interesting evaluation criteria in order to capture at early stage inconsistencies and design weakness.

3.2 Conceptual Framework

Figure 2 overviews the proposed software dependability evaluation framework for mobile learning. ReStart-Me intends to reduce the cost of learning environment quality evaluation through using test cases. It uses formal checking techniques to ascertain inclusion relation between dependability requirements and test cases. Dependability requirements and test cases are modeled into timed automata. Then, they are transformed into temporal logical properties to formal checking methods. If the formal checking produces TRUE then we can conclude that the dependability properties are well implemented into the learning environment. On the other

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hand, in case of FALSE, we generate an errors report and recommendations to assist designers to ensure learning scenario quality.

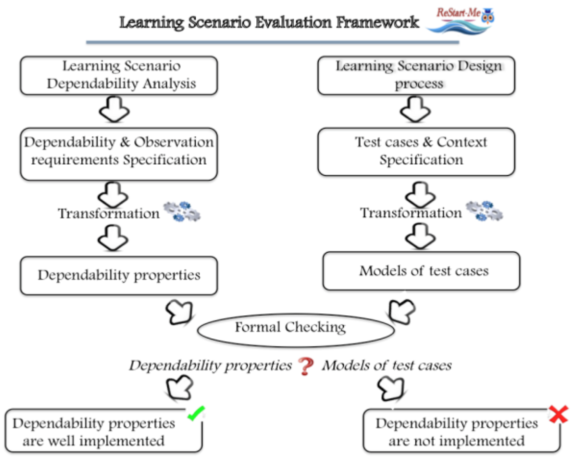

Figure 2. Dependability Evaluation Framework for Learning Scenario.

The evaluation process contains essentially these three steps (see Figure 2) inspired from (Coronato, A. and De Pietro, G. 2010):

- **Pre Step 0: Behavioural Modelling:** this phase provides informal descriptions of both the learning environment and the correctness properties to be checked. Pedagogues and designers have to participate in this phase.
- **Step 1: Formal Modeling of Educational Scenario:** In this step, conceptual designers identify the entities to be considered. Designers have to successively refine it and decide which the final actors to be modelled are. The content of each process is created and redefined by modelling the dynamic behaviour. Then, we extend the obtained automaton with global and local clocks. We also define contextual constraints and correlation between different activities. By creating a formal specification of the learning scenario, the designers are forced to make and to define a detailed scenario analysis at early stage before its deployment into the learning system.
- **Step 2: Tracks Simulation:** Through simulation, we can observe all possible interactions between automata corresponding to different entities involved in the learning scenario. This step generates simulated tracks that facilitate errors detection. A simulation is equivalent to an execution of the designed learning scenario. It gives some insight on how the model created behaves.
- **Step 3: Properties verification**: with formal verification, we check the correctness of the designed learning scenario. This process aims to build a remedial scenario and to help designer in the reengineering process by providing Errors and warning reports.

ReStart-Me can be applied with the help of different developing methods and tools. To exemplify this, we have selected a tool that is well known, efficient and provide us with most of what we need. The selected tool is a model checker that has a modelling language, plus simulation and formal verification capabilities. We think that our choice is well founded but is not essential. To illustrate the application of ReStart-Me, we will use UPPAAL model checker (Bengtsson, J. et al. 1996).

4. EXPERIMENT AND RESULTS

The objective of this study reported in this section is twofold: (i) to check practicality of the proposed framework when building an actual mobile scenario (ii) and to evaluate qualitatively the benefits of such methodology. A team of researchers composed mainly by of five Designers has prepared a textual description of the malleable learning scenario.

These meetings have produced a scenario design document that describes the sequencing of different activities and rules of the malleable learning scenario. To summarize, the learning scenario can be described as follows:

A high school decides to raise awareness of pupils on the effects of pollution on the environment by organizing a trial allowing the follow-up of the pupil's educational curriculum in the field of "Education about the environment". This trial enables pupils to learn through factual cases and to experiment various scenarios using pervasive and mobile technologies.

The physical setting of this trial, where activities take place, is an ecological zone near by an industrial area.

In order to boost intra-group competition, students were divided in three groups under the supervision of their coach and each group consisted of six pupils. Additionally, each group was divided in two subgroups of three students. The ultimate goal behind this clustering is to reinforce teamwork and collaboration within the individual subgroups and to make it a collaborative and challenging game that takes place in different locations.

The outdoor subgroup is equipped with a smart phone with a wireless connection. At the beginning of the first stage, a localization sensor localizes the out door's subgroup and a notification is sent to ask students to identify and take a photo of the QR-code stuck to a tree. Instantly, a text adapted to the pupils' level and pictures that visualize and describe the activities to accomplish in the current stage is displayed on the screen of the smart phone.

In the first stage, the outdoor subgroup can take a photo of a plant and search for a plant related groups and then share the photo and ask for help in identifying it. After a pre-defined time, the subgroup will receive a stage-adapted quiz via automatic text message. Pupils need to write an answer using their smartphone and submit it. If the answer submitted by the group is not correct, the system sends an alert to the coach informing him/her that pupils need some support. The coach should send to them some hints.

In order to improve the coaching task, tutor decides that after three wrong attempts, the pupil is guided to start learning session by using his mobile device. The e-learning client allow the student to directly mash up widgets to create lesson structure and add powerful online test widgets, communication widget (chat, forum and personal messages), content scheduling widgets, communication tracking, announcements, content flows, cooperative content building widgets.

The student could drag from the widget repository and drops into the elearning client UI all the widgets needed for providing video, audio and other multimedia content. The session of learning take 30 minutes with GPRS connection and 40 minutes with EDGE connection.

Else, if the answer is correct the indoor subgroups will receive the list of activities of the second stage and will get joined by their corresponding outdoor subgroups that will hand over the picked plant samples.

At the end, indoor and outdoor subgroups of each of the three groups should collaborate in drawing their own conclusions using the collaborative tool Google Docs and then present the outcome of their study about effects of pollution on environment.

Table 1. Context Information (Network connection quality)

	Zone 1	Zone 2
Type of network	**EDGE**	GPRS

4.1 Modelisation and Evaluation

Figures 3 and 4 provide an overview of different automata modeled for the planned learning activities (outdoor activities, quiz, and lesson) and corresponding to student. We define a global variable "clock" named Time that gives idea about the duration of each activity. The timing constraints associated with locations are invariants. It gives a bound on how long these locations can be active. We also define other global variable Power to calculate the energy of battery of the smartphone.

In order to facilitate the learning scenario analysis, we model each activity separately. The idea is to define templates for activities that are instantiated to have a simulation of the whole scenario. The motivation for the use of templates is that the understanding, the share and the reuse of different components of the learning scenario become easier.

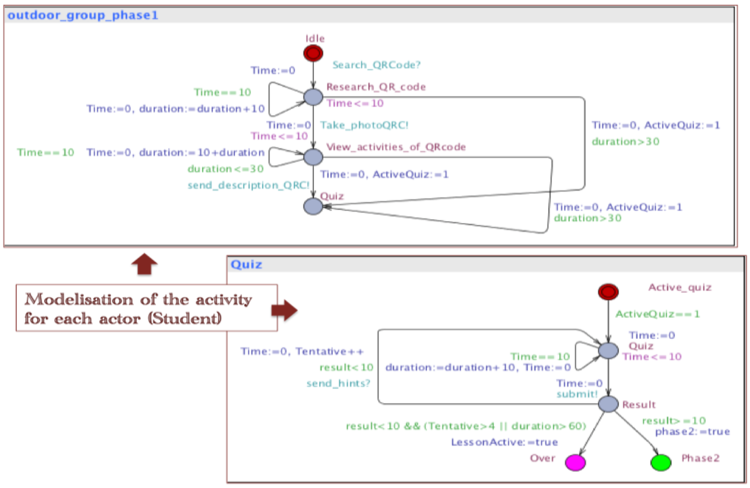

Figure 3. The automata model of different activities for one actor (Student)

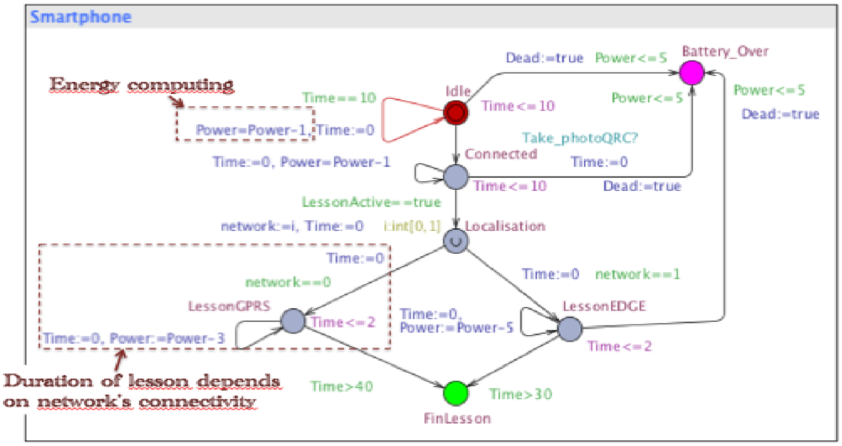

Figure 4. The automaton model of the smart phone

The whole scenario is modelled as a parallel composition of timed automata. An automaton may perform a transition separately or synchronise with another automaton (channel synchronisation) or it can be activated after a period of time through flags.

Based on automata presented above, tracks simulations are generated visualizing all possible interactions between different actors. A screen dump of the simulation of the designed educational scenario is below (see figure 5).

In order to help designers to improve their educational scenario and to obtain better outcomes, through the generated simulations, we try to localize design errors, to answer and to verify the following questions:

- **Does the description of the learning scenario clearly define time constraints for each activity and the whole scenario?**
- **Is there any situation of deadlocks, liveness or starvation?**

A possible situation of deadlock is detected within tracks simulation of the whole scenario; In fact, students could have a period of inactivity especially when they begin their lesson in the first zone (EDGE) where the network connectivity is lower and smartphone' energy is limited. To check this property, we are based on reachability property that is considered as the simplest form of properties. They ask whether a given state formula, possibly can be satisfied by any reachable state. Another way of stating this is: Does there exist a path starting at the initial state, such that "the battery state" is eventually over along that path?

We traduce this property in temporal logic formula: "*E<>Smartphone.Battery_Over*" and this property is verified as shows figure 6. Then, we conclude that dependability is not assured and we had to adapt mobile application to the learning environment context (if the student is located in Zone 1, he had to reduce the energy consumption by loading the necessary widgets).

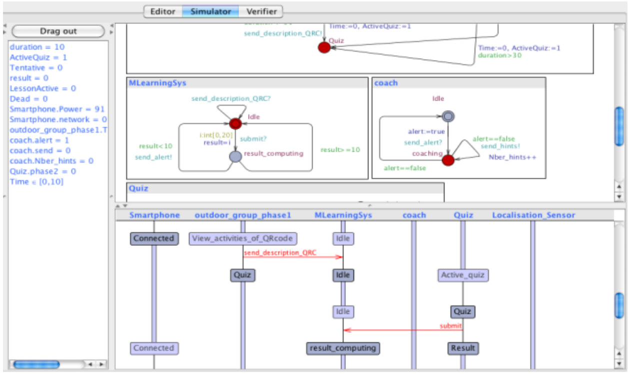

Figure 5. Simulation of the modeled Learning scenario

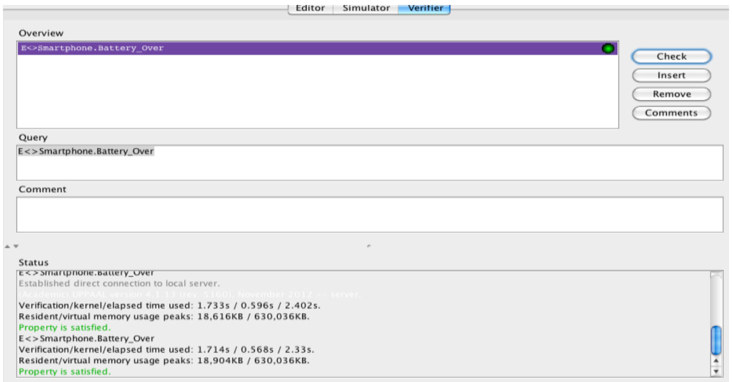

Figure 6. Checking the reachability of the battery state

4.2 Result

The final evaluation was conducted using interviews with five pedagogical designers. During the interview, the engineers have addressed several points about there experiences with the presented methodology. Hereafter a summary of the main points that have been discussed:

- Fours engineers of five have found the methodology very useful in identifying the inconsistencies functional aspects of the learning scenario. In fact the culture of classical learning scenario evaluation does not highlight the importance of these functional aspects (like time, context of learning, ...). In the one hand, thanks to the formal modelisation, we can simulate and check all possible execution exhaustively. In the other hand, it allows us to redefine the conceived learning scenario in more details deeply at early stage in order to avoid the problems highlighted by the evaluation (or on the contrary, to rethink the first design).
- Two engineers have already some experience in developing large learning scenario. So they were aware of the cost of their implementation and revision. Consequently, they pointed out that the early evaluation stage performed before implementation and deployment has helped to revise some fundamental decision without having to conduct costly implementation. In fact, the contextual and formal evaluation shows us if the resulting evaluation is exactly what we expect from the modelisation of learning scenario (and from the learner) before the implementation stage. It may happen, for example, that we want to create a correctly and general design for a complex scenario but the result of the formal evaluation shows that we lack in contextual constraints definition and specification.

- Three engineers of five have pointed out that the formal modeling and verification is not so easy to build. Indeed, this formalism is not very well known by all conceptual designers. For this reason, we are developing a formal modelisation assistant tool to help no-skilled designers to evaluate the conceived learning scenario.

5. CONCLUSION

In this paper, we presented different dimensions that could be evaluated in learning scenario. We proposed a formal framework evaluation to support a contextual evaluation in dependable learning environment. This framework based on formal modelisation and verification allows to designers to simulate the conceived learning scenario with contextual constraints.

Complex content management is employed in m-learning, when there is an interaction between teachers and students. The limit is established by the available technology. It is still a determinant factor in such technologies, the transmission cost and speed, which affects the communication logistic between teacher and student and has a direct repercussion on the learning type. For this reason, we have attempted to demonstrate the benefits of the proposed approach by presenting a realistic case study. We think that this formal methodology of evaluation provides useful information for the re-use and the reengineering of learning materials. In the one hand, it can solve many difficulties in getting proper information about the students and their behaviour (ethical problems, track s' collect,...).

In the other hand, the use of a rigorous formalism to describe a model of deployment allows a better and more precise understanding of the planned scenario. It provides the designer with an analytical model that helps him to detect errors and learner's difficulties through test case generation and deductive verification. Finally, it creates an environment that simulates an external reality and learner's behaviour.

For going farther this first result, we are currently working on two directions: Firstly, we will attempt to deepen our proposal and to apply formal verification relying on temporal logical formulas and model checking engine. Secondly, in order to assist the designer in expressing these properties, we are developing a tool that helps him/her to draw this business requirement and to generate error report automatically.

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INITIAL EVALUATION OF A MOBILE SCAFFOLDING APPLICATION THAT SEEKS TO SUPPORT NOVICE LEARNERS OF PROGRAMMING

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ABSTRACT

The aim of this paper is to explore the use of an application that scaffolds the constructions of programs on a mobile device. The application was developed to support novice learners of programming outside the classroom. This paper reports on results of a first experiment conducted to evaluate the mobile application. The main research questions are: (i) whether the use of the application is effective in supporting construction of programs on a mobile device; and (ii) how the learners experienced the use of the mobile application. Data was collected by task completion, video and audio recording, and a questionnaire. A total of 18 first-year learners of programming from two African universities took part in the experiment by participating in focus groups. Almost two thirds of the learners completed two out of three programming exercises using the mobile application, with all the learners completing the first program. The results of the study suggest that the students found the mobile application useful, as evident from high rating of its features. The results also consisted of feedback from the learners on features that would make the application more usable. The findings suggest that the use of a mobile scaffolding application may support novice learners of programming outside the classroom. The outcomes of these results lead to a clearer understanding of how to design a mobile application that scaffolds the construction of programs on a mobile device.

KEYWORDS

Mobile, Evaluation, Programming, Support, Scaffolding, Novice Learner.

1. INTRODUCTION

Difficulties encountered while learning computer programming are a universal problem. There have been numerous attempts to tackle these difficulties (for example (Apiola et al., 2011) (Lahtinen et al., 2005)); but these challenges still remain. Hence, effective instructional strategies and optimal learner support mechanisms should be developed, to provide learners of computer programming with the optimal learning environment that they need (Mow, 2008).

These difficulties show that some programming skills that novice learners need are beyond their abilities. Scaffolding refers to support provided so that the learner can engage in activities that would otherwise be beyond their abilities (Jackson et al., 1998). Providing this support outside the classroom could contribute to tackling learning difficulties. Support is emphasized upon because any such support should be additional to the learners' classroom learning, and not a replacement. Providing support outside the classroom aims to make the most of the resources available to support learning, by making their provision more flexible, open and responsive to the needs of individual learners (Bentley, 2012).

The ubiquity of mobile phones provides an opportunity to use them as a resource to support learners beyond the classroom. In addition, mobile phones can be used by learners in resource-constrained environments who own a mobile device but cannot access PCs outside the classroom. Mobile phones can also be used when and where using a PC would be inconvenient.

In order to exploit the ubiquity of mobile phones to provide support to novice learners of programming, an application was developed that scaffolds the construction of Java programs on a mobile device (Mbogo et al., 2013). The design of the application took into account the theoretical fundamentals of constructivism, and used a learner-centered methodology that combined learners' needs and limitation of mobile devices to choose scaffolding strategies. For the sake of illustration in this paper, this mobile application will be referred to as *ScafFold*.

ScafFold is a mobile application developed for the Android platform, aimed at supporting learning of programming by scaffolding the construction of Java programs on the mobile device. Java was chosen as the language for constructing the programs because it is commonly taught in undergraduate courses. Android was selected as the platform of implementation because it is open source, and it also has an 80% market share among smartphone users (Dara, 2013). ScafFold runs on Android version 2.2 upward. The current version is for evaluation purposes only and it is not available for download.

ScafFold provides scaffolding by: representing a program in five chunks that represent parts of a Java program; restricting a learner to complete a program in a certain order; enabling construction of a program one chunk at a time; providing instructions, default code, steps, hints, examples and error prompts where appropriate; and fading the scaffolds as the learner progresses from one successfully completed and compiled program, to the next. Figure 1 shows the main interface of Scaffold, which shows the five chunks and a step provided. Figure 2 shows the main class chunk complete (in green), and the header expanded to reveal some automatically generated code. Figure 3 shows an example of an error prompt displayed if the class name is completed inappropriately.

Figure 1. Main interface

Figure 2. Main class created

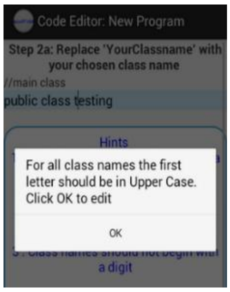

Figure 3. Error prompt

This paper reports on results of a first experiment conducted to evaluate ScafFold. The evaluation was based on a three-level framework (Vavoula & Sharples, 2009), and sought to answer the research questions: Is the use of the application effective in supporting construction of programs on a mobile device? What were the learners' experiences in using the mobile application?

In attempting to answer the research questions above, the following parameters were evaluated: usability of the application; desirability of the features of the application as rated by the learners; and user experience while constructing programs using the mobile application.

In summary, the contribution of this paper is twofold: Presentation of findings from evaluation of a mobile scaffolding application; and Illustration that a development environment with adaptable scaffolding can improve the effectiveness of constructing programs on a mobile device.

The rest of the paper is organized as follows: Section 2 describes related work; Section 3 describes the study methodology, including the e-survey methodology, focus groups and task list; Section 4 briefly discusses the evaluation framework and presents the findings from the survey; and Section 5 concludes the paper.

2. RELATED WORK

The most relevant study in terms of a mobile intervention is TouchDevelop, an application that provides a programming environment, language and a code editor (Tillmann et al., 2012). This mobile application was built for the Windows platform, and employs a semi-structured code editor, which allows for pre-selection of statement kinds and expression tokens. Semi-structured code reduces the cognitive load on learners in memorizing statements and expressions that they would need. TouchDevelop also shows a listing of a complete program. Showing a full program would enable a learner to relate the program part they are working on with the whole view. TouchDevelop does not employ the use of chunks to display a program in parts, an approach that the work described in this paper takes. The TouchDevelop study evaluated the application with high school and 8th grade learners. The results of the study indicate that a programing environment that runs on a mobile device has the potential to dramatically reduce the technical learning overhead. This paper identifies with these results as a motivation to provide mobile support outside the classroom.

The most relevant study in terms of application of the scaffolding theory is a PC-based application, known as Pseudo-code Development Environment (PDE) (Costelloe, 2004). It allows learners to select the level of problems they wish to work on. The aim is to facilitate guided-learning by doing, and lead the learner to a solution by offering feedback and subdividing the tasks into more manageable sub-tasks. Use of feedback and subdivision of tasks is an approach that the work described in this paper identifies with. PDE also provides a problem category selection such as sequence problems or iteration problems. One way that PDE subdivides a task is by having a learner indicating input data by answering a question on how many inputs a problem needs. PDE is suited for creation of pseudo-code where specification of input could be necessary. However, in creation of a program, a learner does not need to specify input prior to writing the program. Further, since PDE was tailored for pseudo-code creation, it did not make provision for running and compilation of a program.

To summarize, the study in this paper is related to a number of findings and results that have appeared in related contexts. The contribution is not only to report the findings from an initial evaluation of the mobile application, but also to show that a development environment with scaffolding could improve the effectiveness of constructing programs on a mobile device.

3. STUDY METHODOLOGY

3.1 Study Design

The study was conducted in two Universities: University of Cape Town (UCT) and University of Western Cape (UWC). The two universities were selected for this study due to their convenience in terms of having established contacts. A total of 18 first-year learners of programming from the two universities participated in the experiment: 8 from UCT and 10 from UWC. 17 of the learners studied Computer Science, and 1 student studied Electrical and Computer Engineering; all were at Bachelors level.

Prior to starting the experiments, ethical clearance was obtained from the participating universities. Prior to participating in the experiment, all the learners were briefed on the purpose of the research and were requested to complete a consent form that declared: not having used the mobile application before; voluntary participation; freedom to withdraw from the experiment at any time; consent to use audio/video/image recording; and use of their anonymised feedback. The learners at UCT were given incentives of R50, while the learners at UWC were provided with lunch.

A multi-method approach was adopted in the study in order to collect as much data as possible. The study methodology included the following: the learners first participated in focus groups, which consisted of 2 to 10 participants at a time; in the focus group, a task list was issued ,which consisted of programming exercises to be completed using the mobile application; during the focus group, video and image recordings were taken; after the focus group, an electronic survey (e-survey) was issued, which consisted of a questionnaire that collected demographic information and user feedback about the application.

3.2 The e-Survey Methodology

The e-survey methodology has the advantages of decreased cost, faster response times and increased response rates (Lazar & Preece, 1999). The e-survey methodology was used for these reasons and was designed using Limesurvey[1]. The intent of the survey was clearly outlined in the introduction of the survey, enabling well-informed participation and consent. The participants' privacy and confidentiality was ensured by not asking for personal information such as names or identification numbers. A computer was provided at the venue of the focus groups for completion of the questionnaire at the end of the session. A total of 16 learners completed the questionnaire. 2 of the learners could not complete the questionnaire due to time constraints as they were attending a class session immediately after the focus group. The questionnaire had three sections: demographic information; interface usability; and user experience.

[1] http://www.limesurvey.org/

3.3 Focus Groups Methodology

Focus group participants were recruited through random sampling after announcements in first-year programming classes. The participants volunteered for the experiment. The focus group approach is defined as a research technique that collects data through group interaction on a topic determined by the researcher, and involves a group of participants and one or more moderators (Colm et al., 2011). For the evaluation of an artifact design, an exploratory focus group studies the artifact to propose improvements in the design (Tremblay et al., 2010). The artifact in this study is the mobile application. At UCT, the learners participated in 3 1-hour long focus groups in groups of 3, 2 and 3 learners respectively. At UWC, all the 10 learners participated in a single focus group during a 1-hour lunch break session. In both locations, all the learners were provided with Android mobile phones to use for completing a programming task, which is described in the next section. Learners did not use their own mobile devices to complete the tasks.

3.4 Task Completion

The learners were required to complete a task that consisted of three Java programming exercises. A task list was used so that when a user goes through an interface, they are goal-oriented by completing specific tasks. (Lazar et al., 2010). The programming questions that the learners were required to complete are:

1. Write a program called **Testing** that prints the words ‘This works!’.
2. a.) Write a program called **Odd** that uses a for-loop to print the odd numbers from 1 to 20.
b.) Write a program that calculates the area of a room that is 10 meters wide and 25 meters long.
3. Write a program that requires input of your name and outputs it in the format ‘Your name is X’.

Hint: Use the BufferedReader class on the mobile application to accept user input.

Some of the learners completed 2 a.), while others completed 2 b.). This was by choice of the learners on instruction that they could complete either.

3.5 Video and Image Recording

3 students were recorded while they were completing one of the programming exercises. The video recordings give insight to some tacit information and interaction with the application. The video camera was close enough to capture the learners’ interaction with the application, but not too close to interfere with the interaction. From time to time, still images of the learners’ mobile screenshots were captured. For example, Figure 4 shows the output of a completed task. The video and image recordings were analyzed alongside the feedback from the questionnaire, as described in the evaluation section.

Figure 4. Output of task 2(a)

4. EVALUATION AND FINDINGS

A three-level evaluation framework was used (Vavoula & Sharples, 2009) to evaluate the mobile application. These levels are Micro, Meso and Macro levels. The *micro* level evaluates the usability of the application, and seeks to find out if the application is designed in such a way that it is usable while constructing programs on the mobile device. A questionnaire was used as the data collection mechanism for the micro level. The *meso* level evaluates the user experience and seeks to find out: if the use of the application is effective in supporting the construction of programs on a mobile device; and learners' cited experiences while using the application. Task completion in the focus group, video and image recordings, and a questionnaire were used as data collection methods for the meso level. The *macro* level evaluates the impact of the application on learning practices, and also finds out the learners' experiences while using the application, and if the application improves their learning processes. This study will evaluate findings at the micro and meso levels. The macro level is left for future evaluations, which will involve experiments over a longer period of time. Using this framework, the findings are grouped into three sections: usability; desirability of the features of the application; and user experience.

4.1 Usability

To measure evaluation, the learners were asked to fill a questionnaire at the end of the focus group session that required them to indicate the usability of the application. Table 1 shows 9 heuristic features used to measure usability. Each question was measured using a five-point likert scale that ranged from 'strongly disagree' to 'strongly agree'. The table shows the percentage of the 16 learners who responded to each category.

Generally, the application was cited as mostly useful in terms of interface usability. This is evidenced by 6 of the 9 features having at least 80% combined positive feedback of 'agree' and 'strongly agree'. Clarity of labels, consistency in words and actions, availability of guidance and assistance, and legibility of textual aspects were indicated as the best usability features in the application. However, lack of sufficient feedback and presence of too much information on the editing interface were cited to be the most limiting factors and need improvement. Some of the additional comments (cited verbatim) that the learners' gave in terms of improvement of usability include:

- The instructions were hidden and I didn't know where to look to get the next one. I suggest using a tabbed interface and not a list view.
- Some of the options, such as compile and run, should be made more accessible.
- Sometimes undoing an action was not clear. Doesn't give you the option of undoing fully.
- There is too much information on the coding screen.
- Textual aspects should be distinguished by different colours to be more recognizable.

Table 1. Responses on usability of the mobile application

Heuristic\Scale	**Strongly disagree**	**Disagree**	**Neither disagree nor agree**	**Agree**	**Strongly agree**	**Combination of Agree & Strongly Agree**
Attractiveness	0%	6%	25%	50%	19%	69%
Easy to follow and use	0%	6%	0%	50%	44%	88%
Sufficient feedback	6%	6%	0%	50%	38%	88%
Clear labels	0%	0%	6%	38%	56%	94%
Clear ways of undoing/redoing	0%	6%	25%	25%	44%	69%
Consistent words/actions	0%	0%	6%	69%	25%	94%
Guidance/assistance	6%	0%	0%	44%	50%	94%
No irrelevant information	0%	19%	25%	31%	25%	56%
Legible textual aspects	0%	6%	0%	50%	44%	94%

4.2 Desirability of the Features of the Application

The learners were asked to indicate the extent to which they agreed that the scaffolding features of the application support the construction of programs on the mobile device. Table 2 shows how the learners rated the different scaffolding features of the application in terms of agreeing and strongly agreeing. The last column gives the combination of these two sets of responses per feature. The features with the highest percentages in the last column are the most perceived to effectively support constructions of programs on a mobile device. Availability of hints, presentation of programs in chunks and provision of steps that enable the user to interact with the application, were indicated by the learners as most desirable. Error prompts and provision of default code were the least desirable features as rated by the learners.

Table 2. How the learners rated the different features of the application in terms of effectiveness in supporting construction of programs on a mobile device

Scaffolding features	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Combination of Agree & Strongly Agree
Presentation in chunks	0%	12%	0%	63%	25%	88%
Completion part at a time	0%	13%	6%	38%	43%	81%
Steps to interact with application	0%	0%	12%	63%	25%	88%
Availability of hints	0%	0%	6%	38%	56%	94%
Error prompts	13%	12%	6%	44%	25%	69%
Dialog prompt of options e.g 'System.out.println()',	13%	0%	0%	31%	56%	87%
Provision of default code	0%	19%	19%	31%	31%	62%
Provision of examples	0%	6%	18%	38%	38%	76%
View of full program at any time	0%	0%	19%	38%	43%	81%

4.3 User Experience

4.3.1 Task Analysis

All the 18 learners who participated in the survey completed the first programming task. Two-thirds of the participants completed the first two programming exercises. Only two learners managed to complete the 3rd exercises that required usage of the BufferedReader class to accept user input. Learners indicated that they had not learnt the use of the BufferedReader in class, but had been taught use of the Scanner class for input.

4.3.2 Challenges Encountered

All the learners indicated that the application can fit in a novice's learning environment to effectively support construction of programs on a mobile device. However, during the task completion, the following challenges were experienced by some of the learners and also observed:

1. The video recordings showed that the learners hardly scrolled to view information that is not readily visible on the screen. In several instances, learners kept clicking on a non-active button, while the instructions on what to do next were at the bottom of the screen, which would have been visible upon scrolling. This gives an indication to try out different screen interactions like: usage of tabs, as suggested by some learners; and also use of hierarchical views that can be expanded (Churchill & Hedberg, 2008).
2. In some instances, the learners completed a full program all within the class declaration (Figure 5). Upon pressing the back button to go back to the main interface, the learner got a prompt informing them that the class declaration required only one line. This indicates that the application could be improved to provide immediate prohibition of unrequired code, and not wait until the learner attempts to proceed.

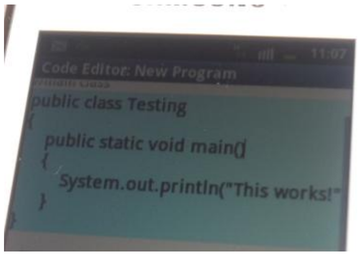

Figure 5. Task 1 created within class declaration

3. Despite provision of a dialog box to select some statements to use, some learners opted to ignore the prompt and type the statements on their own. A commonly occurring instance was the provision of a dialog box that provided a choice of preselecting 'System.out.println()', and therefore just required users to fill the required output inside the brackets. But some learners opted out of the dialog box and typed the statement from scratch. Some provision of alerting the learner that they can preselect the statements even if they opt out would be helpful, especially because these pre-selection dialog boxes were some of the highly rated features of the application.

4. A major challenge was the soft key pad covering the nearly three-quarter of the screen while typing. This blocked some of the instructions and hints, and some learners missed these. This was especially so in the code editing screen, but not a major problem in the main interface. One approach to handle this in the code editor would be to use tabs at the top of the screen as opposed to the bottom for hints, examples and instructions. Indeed, a study suggested that scrolling can be reduced by placing navigational features in the fixed place near the top of presented resource, and by placing key information at the top (Jones et al., 1999).

5. In some situations, the wireless network was very slow and hence slowed down the compilation phase. Some of the learners switched to the data network, which turned out to be more reliable than the school wireless networks.

5. CONCLUSION

This paper has reported upon results of an evaluation of a mobile scaffolding application. A majority of the learners completed most of the programming tasks. They indicated that the features of the application effectively support construction of programs on a mobile device. The highly rated features are: hints; steps; presentation of programs in chunks; pre-structured dialogs; completion of one chunk at a time; and view of the full program. Further, the learners indicated that the application is usable due to having clear labels and textual representation, consistency in words and availability of guidance and steps.

However, as literature reveals (Churchill & Hedberg, 2008) and also as pointed out by the learners, mobile phones present several challenges in their use to support learning. Thus, if mobile phones are to be effectively used to support construction of programs on a mobile device, the design and presentation has to be optimized for mobile phones. According to the feedback from the learners and also literature (Churchill & Hedberg, 2008) (Jones et al., 1999), this can be done in several ways: minimize the amount of text on the screen by providing tabs to navigate through the information; make important links such as compile and view of full program more visible, provide hierarchical views of information; create tabs at the top instead of the bottom of the screen to take care of the soft-keypad of touch screens; and enable clear ways of undoing and redoing a task.

The results of the evaluation suggest that the use of a scaffolding application may support construction of programs on a mobile device; this warrants further study. The experience of learners using the application can be made more effective based on user feedback, supported by underlying theory and existing research. These results lead to a clearer understanding of how to effectively design a mobile scaffolding application to support learners outside the classroom.

Although the findings are encouraging and useful, the study in this paper has certain limitations. Firstly, the application was developed for the Android platform and this presents a limitation in the number and type of mobile platforms it can be tested on. The application is developed to be used with the Java programming language; however, it is acknowledged that not testing it using the other programming languages could be limiting. In addition, the programming exercises used in this initial evaluation are simple and therefore present a limitation in the extent to which the application can be used to support more difficult tasks. A future evaluation will include exercises that cover more advanced tasks. The number of participants in the evaluation was also limited and some key feedback could have been missed. Future work involves evaluating the mobile application with a larger number of undergraduate programming learners over a longer period of time. Finally, current work seeks to implement the feedback obtained from the learners into a second iteration of the mobile application.

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DEFINING A SET OF ARCHITECTURAL REQUIREMENTS FOR SERVICE-ORIENTED MOBILE LEARNING ENVIRONMENTS

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ABSTRACT

Even providing several benefits and facilities with regard to teaching and learning, mobile learning environments present problems and challenges that must be investigated, especially with respect to the definition and standardization of architectural aspects. Most of these environments are still built in isolation, with particular structures and architectures, hindering aspects such as reuse and interoperability, for instance. On the other hand, several initiatives of using service orientation aspects to support and help the architectural definition of software systems have been investigated. Motivated by this scenario, in this paper we propose a set of architectural requirements for service-oriented mobile learning environments. The architectural requirements are defined by means of a systematic process, being prioritized and complemented with the help of domain experts. In the very end, the main goal is to provide an adequate support for the architectural design of mobile learning environments, promoting quality, interoperability, reuse and reduction of the time spent in the development of such environments.

KEYWORDS

Architectural Requirements, Mobile Learning Environment, Service Orientation.

1. INTRODUCTION

Virtual learning environments, together with the advent of ubiquitous computing, have provided a new and innovative way of education – the mobile learning (*m-learning*) (Martin, 2010). In short, m-learning is characterized by the ability to promote a strong interaction among apprentices, teachers and tutors, enabling them not only to access the learning environment but also to contribute and actively participate of the knowledge construction process through mobile devices (e.g., mobile phones, tablets, laptops, radio, tv, among others).

Despite the benefits provided, mobile learning is still faced as a new and incipient concept, presenting some limitations that difficult its effective adoption, such as (Jong et al., 2008): (1) reduced processing power; (2) variable screen size; (3) limited energy (battery dependent); (4) transmission rates that are generally smaller than those of the fixed network; (5) adequacy to usability aspects; and (6) lack of architectural patterns.

Considering the need of building quality and reusable mobile learning environments, efforts for developing architectural patterns have become increasingly relevant. Software architectures dealing with aspects of SOA (Service-Oriented Architecture) have gained particular importance within the context of mobile learning (Otón et al., 2010; Palanivel and Kuppuswami, 2011). However, in spite of such efforts, there is still a lack of a standardized set of architectural requirements, specifically defined to the mobile learning domain and in accordance with service-oriented issues.

In short, an architectural requirement can be defined as any requirement that is architecturally significant (e.g., performance, usability, reuse, security, interoperability, adaptation, among others), with particular responsibilities in relation to a given software domain (Schepman et al., 2012). The right definition of these requirements provides a better abstraction of the system to be developed, helping and supporting its architectural representation.

Motivated by this scenario, in this paper we propose a set of architectural requirements for service-oriented mobile learning environments. The requirements are defined through a systematic process, which supports the design, prioritization and complementation of architectural requirements. In the end, we intend to promote interoperability, domain comprehension, architectural reuse, better quality and reduced time spent in the development of these environments.

2. BACKGROUND

M-learning has appeared as a new type of electronic learning, taking place when the interaction among the actors of the learning process is performed through mobile devices. As a new and emerging paradigm, there are several attempts for defining m-learning. According to Schepman et al. (2012), m-learning refers to any kind of learning that occurs when the apprentice is not in a fixed place, or when he/she takes advantage of learning opportunities provided by mobile devices, thereby relating technological and mobility concepts. Ozdamli and Cavus (2011), in turn, address m-learning as an activity that allows individuals to be more productive when they consume, create or interact with information, supported by mobile devices.

No matter the definition adopted, the use of learning environments through mobile devices provides benefits that go beyond accessibility, convenience and communication (Schepman et al., 2012). However, despite the advantages offered and even with the increasing research related to the development of mobile learning environments, there are few works dealing with a well-established set of architectural requirements in this new learning setting (Efstratiou et al., 2000).

Due to the complexity and lack of architectural standardization regarding m-learning environments, difficulties concerning the use, integration, maintenance and reuse of these environments are still common during their development. In this sense, the adoption of a SOA approach can make the construction and adoption of m-learning environments be easier and more flexible, promoting interoperability and reuse of best practices in the educational scenario (Erl, 2009).

Some initiatives regarding the definition of service-oriented architectural requirements for m-learning environments can be found in the literature (Section 3.1). Such initiatives, however, are spread out, with no kind of standardization with respect to educational practices and issues of mobility and service-orientation (Erl, 2009; Otón et al., 2010; Basaeed et al., 2007; Thanh and Jorstad, 2005). Besides that, the establishment of architectural requirements for software systems in general, and for mobile learning environments in particular, is not a trivial task (Efstratiou et al., 2000). Guidelines to support the architectural design process and, at the same time, ensure the correct understanding of the specificities of the target domain, are required (Duarte Filho and Barbosa, 2013).

In a different but related perspective, Nakagawa and Maldonado (2007) worked on a process to support the development of reference architectures, referred to as ProSA-RA (Process based on Software Architecture - Reference Architecture). ProSA-RA focuses on how to deal with architectural aspects as well as on how to represent and evaluate reference architectures. The process comprises four basic steps: (1) Information Sources Investigation; (2) Architectural Requirements Establishment; (3) Reference Architecture Design; and (4) Reference Architecture Evaluation. In our work, we are particularly interested in Step 2 of ProSA-RA, since it establishes some general guidelines to identify and describe the common functionalities and architecture requirements presented in software systems.

Based on ProSA-RA (Step 2), we established a smaller but systematic process for the determination of architectural requirements. The process was applied in the context of mobile learning environments in order to define the architectural requirements for this domain. The process and its application are described next.

3. A PROCESS FOR THE DEFINITION OF ARCHITECTURAL REQUIREMENTS

The establishment of the set of architectural requirements for mobile learning environments was performed through the systematic process. The process comprises four main steps: (1) Application Context Definition; (2) Identification and Analysis of Information Sources; (3) Design of Architectural Requirements; and (4) Prioritization and Complementation of the Architectural Requirements.

3.1 Step 1: Application Context Definition

Due to variety of the applications for mobile learning environments (e.g., distance, simulations, games, and many others), in the first step, firstly it is necessary to set the context for which these environments will be directed, thus being able to define the most appropriate architectural requirements for the environment. The application context was defined for mobile learning environments that can support traditional courses at undergraduate level and that can support learners in relation to basic education activities (e.g., activities submission, messaging, access to educational materials, among others). Teachers and tutors, which will also benefit of the environment, can monitor and track the activities of the apprentices. This context was defined due to the authors' experience in this application domain, experiencing and using daily environments in this learning setting. This facilitates the identification of advantages and disadvantages in an educational environment.

3.2 Step 2: Identification and Analysis of the Information Sources

In this step, the idea is to get considerable knowledge about the target domain. This knowledge acts as a basis for the establishment of the architectural requirements. In our case, three groups of information sources were defined, based on their relevance in the context of mobile learning environments and SOA: (1) Concrete Architectures for Mobile Learning Environments; (2) Reference Models/Architectures for the Educational Domain; and (3) Service-Oriented Architectures.

3.2.1 Concrete Architectures for Mobile Learning Environments

In general, the research works analyzed in this group address issues related to communication, security, modularity, adaptation to the context and interoperability through service-orientation.

Otón et al. (2010) highlight two relevant aspects regarding the development and implementation of a learning system – reuse and interoperability among repositories of learning objects. Similarly, these aspects remain significant for investigation in mobile learning environments as well. In this sense, the authors presented a service-oriented architecture, implemented through web services, as a means to provide the recovery of learning objects.

In the same perspective, Palanivel and Kuppuswami (2011) define a reference architecture for service-oriented learning environments. The service-oriented aspects provided higher interoperability, reuse, modularity and scalability to the educational practices.

Jong et al. (2008) discuss a reference model for social mobile systems such as social networking and learning systems. These systems are used by multiple users, allowing intercommunication among other participants. The reference model particularly focuses on issues of communication, adaptation to the user's context and security when exchanging information (to ensure confidentiality and integrity).

The MOBIlearn project (Lonsdale et al., 2004) defines several educational services focusing on the user's adaptation. Thus, adaptation is a relevant issue to virtual learning environments, since the student's behavior is modified according to: (i) the inherent characteristics of the environment; and (ii) the content with which the student interacts.

Basaeed et al. (2007) propose an architecture for contributing to the learning process by means of web standards and web services. The authors apply a systematic approach to identify components based on the contextualization of learning, establishing their functionalities and features through web services.

Thanh and Jorstad (2005) propose a service-oriented architecture for mobile services. The requirements considered in the architecture are identified from a generic model of mobile services, which specifies: services for content delivery, services of user's management, scalability, addition of new services and security, among others.

Trifonova and Ronchetti (2004) also propose a generic architecture for supporting mobile learning. In such architecture, the functionalities of learning environments are presented as web services aiming at providing scalability, interoperability and reusability of educational content. Furthermore, characteristics such as communication and adaptation should also be addressed in the context of mobile learning environments. Actually, these characteristics, together with the characteristics of web services (discussed in Trifonova and Ronchetti, 2004 and Basaeed et al., 2011), are important in order to promote portability, reuse and scalability.

Differently from the works presented so far, Martin (2010) analyzes the need for a secure and interoperable architecture. The architecture proposed in his work establishes some basic features with respect to a generic learning environment, such as: privacy, scalability, synchronization, extensibility and reusability, distributed resources and learning resources.

From the study and analysis of the works summarized in this section, a preliminary set of architectural aspects with respect to architectures for mobile learning environments has been identified, highlighting the need for studying and adopting service-oriented aspects, such as: (1) service orientation: to allow more flexibility and interoperability; (2) adaptation to context: to provide the users a context-based learning according their location and the type of application; (3) communication: to guarantee a standardization among the data communication models; (4) security: to provide a private and reliable environment and, at the same time, synchronized with other system users; and (5) modularization: to be structured in modules and components in order to promote a better reuse, modification and quality through the lifecycle.

3.2.2 Reference Models/Architectures for the Educational Domain

The analysis of reference architectures is particularly relevant to the identification of architectural requirements, since from their representations and descriptions is possible to identify general concepts related to educational practices.

The MoLE Project (2013) specifies a reference architecture structured in components and layers to specifically suit the main practices and activities of m-learning. The proposed architecture is based on a set of mobile educational services (e.g., user authentication, data synchronization and reporting) whose goal is to enable a better integration among educational environments.

Additionally to the basic services related to integration of the mobile services, the architecture has a module, the "mobile authoring tool", that allows the creation and sharing of educational content in a mobile way. Some of the main functionalities provided by this module are: (1) creation of tasks; (2) creation of automatic evaluations; (3) creation of quizzes and questionnaires; (4) creation of didactic materials; (5) creation of exercises and tests; and (6) creation of online evaluations.

In another project, the IMS Global Learning Consortium (2013) proposes an educational reference architecture focused on service orientation. The initiative establishes guidelines with respect to the integration and representation of educational practices, without addressing however mobility and ubiquitous issues. The architecture is structured in four layers: (1) application layer; (2) application services layer; (3) common services layer; and (4) infrastructure layer. A set of educational services for supporting educational practices is also proposed: (i) course administration services; (ii) authoring services; (iii) evaluation and communication; (iv) delivery of educational content; (v) customization; and (vi) course documentation.

Finally, based on a detailed analysis of features and functionalities of several different learning environments, Barbosa et al. (2013) propose a reference architecture for learning environments, referred to as EducAR. Particularly, EducAR has an authoring module, responsible for supporting the development of educational content. Basically, this module addresses issues such as: (1) content structuring and modeling; (2) content edition; (3) automatic generation of content; (4) sharing, reuse and integration of content; and (5) content capture. Since EducAR has been developed for "traditional" learning environments, mobile issues have not been addressed on its definition.

Based on the results discussed in this section, key concepts representing the basic functionalities of mobile learning environments could be determined. Thus, the set of architectural requirements should take in consideration concepts (and their relation with educational practices) such as: (1) adaptation to context; (2) adaptation to learning standards; (3) user management; (4) course administration; (5) content authoring; (6) content delivery; (7) user evaluation; (8) course and system documentation; (9) communication; and (10) customization.

3.2.3 Service-Oriented Architectures

In order to identify characteristics for providing a better reuse and interoperability of services among mobile learning environments, aspects of service orientation should also be considered. Specially, we have investigated models and reference architectures for service orientation, as discussed next.

Alzaabi et al. (2010) propose a reference architecture for the architectural description of SOA. As a complement, Zimmermann et al. (2009) define a reference architecture to ease and support the development of service-based systems.

The OASIS project (2006) establishes a common vocabulary and a reference model for the service-oriented architectural style. The model defines relationships and main concepts regarding the SOA domain, such as: visibility, description of services, policies and contracts, ways of interaction, and execution context.

Finally, based on different implementations of service-oriented systems, Dillon et al. (2007) deal with a reference architecture based on reverse engineering. This architecture takes into consideration the analysis and addition of requirements (functional and nonfunctional) already implemented, being supported by the best practices of implementation of service-oriented systems.

From the works analyzed, we point out as the main concepts and functionalities required for the development of a service-oriented system: (1) service description; (2) service publication; (3) service interaction; (4) governance; (5) quality of service; (6) service composition; and (7) policies.

3.3 Step 3: Design of the Architectural Requirements

In this step, all the characteristics previously identified (Step 1) must be analyzed and mapped into architectural requirements. In our case, the mapping was performed with the help of researchers and domain experts in order to facilitate the determination of the relevant architectural requirements to the context of mobile learning. Additionally, the architectural requirements defined were also analyzed with respect to a set of mobile learning environments, aiming at verifying the relevance of these requirements in real learning environments. The environments considered for this analysis/comparison were: *Blackboard Mobile*[1]; *Desire2Learn*[2]; *Mobl21*[3]; *Amadeus Mobile*[4]; *MLE Moodle*[5]; e *Mobile Sakai*[6]. Such environments were chosen based on their good rates of usage by learners, teachers and tutors.

3.4 Step 4: Prioritization and Complementation of the Requirements

In order to validate the requirements identified in Step 3, the next step of the systematic process consists of conducting a prioritization and complementation of such requirements with the support and knowledge of specialists. Priorities were defined throughout of research with the help of 50 domain experts, which participated in online interviews conducted through checklists. Of the 50 specialists, 33 answered the checklist, providing feedback regarding the requirements defined. The checklist was created as a template in order to facilitate its application by the evaluator.

The prioritization was denoted by the symbols: *(NA)* Not Applicable; *(+)* Unsatisfying; *(++)* Regular; and *(+++)* Satisfactory. The idea is to denote the relevance and impact that these requirements have on service-oriented mobile learning environments. It is worth to notice that the architectural requirements prioritized as (NA) were discarded from the set of architectural requirements, since their applicability was not verified in the prioritization.

4. ARCHITECTURAL REQUIREMENTS FOR M-LEARNING ENVIRONMENTS

After the prioritization and complementation, the requirements were mapped into a set of architectural requirements for service-oriented mobile learning environments. In short, the set of requirements was defined by four specific areas, being divided into four distinct groups: Architectural Requirements for Learning Environments in General (AR-GSL); Architectural Requirements for Mobile Learning Environments (AR-ML); and Architectural Requirements specific to SOA (AR-S).

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[1] http://www.blackboard.com/platforms/mobile/overview.aspx
[2] http://www.desire2learn.com/
[3] https://www.mobl21.com/
[4] http://amadeus.cin.ufpe.br/index.html/
[5] http://mle.sourceforge.net/
[6] https://confluence.sakaiproject.org/display/MOBILE/Home

4.1 Architectural Requirements for Learning Environments in General

1-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **provide information about the course**;
2-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **provide information about the system/environment;**
3-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **allow the customization** of the educational content;
4-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **automate the evaluation process**;
5-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **support the authoring of didactic material**;
6-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **provide security** to their users in relation to aspects of mobility;
7-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **enable the management of content** by the instructors and administrators;
8-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **enable learners' evaluations**, in a formal or informal way;
9-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **support the delivery of didactic material**, being possible to explore different media interactions;
10-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **provide feedback mechanisms for evaluation**, which can be conducted by means of scores, reports or even messages;
11-AR-GSL (+++) - The architecture should support/enable the development of learning environments that **manage the users and courses**, with different profiles and visions.

4.2 Architectural Requirements Specific for Mobile Learning Environments

1-AR-ML (+++) - The architecture should allow the development of m-learning environments that **manage the use of resources**, allowing the environment to use appropriate types of resources in relation to mobile devices, especially the bandwidth and memory consumption;
2-AR-ML (++) - The architecture should enable the development of m-learning environments that provides **mechanisms for the efficient energy consumption**. The idea is to ensure energy conservation techniques for mobile devices, saving power when no activity is being performed, guaranteeing greater energy autonomy over learning;
3-AR-ML (++) - The architecture should support/enable the development of m-learning environments that **allow synchronous and asynchronous communication** (among learners/tutors/system);
4-AR-ML (++) - The architecture should enable the development of m-learning environments that provide the **knowledge just-in-time**, allowing the knowledge of the learning object can be led and represented in anywhere, ensuring authenticity in their activities regardless of their location;
5-AR-ML (++) - The architecture should support/ensure **accessibility adapted for mobile devices**, supporting different languages of the communication and cognition (e.g., screen magnification/zoom, screen rotation, customization of colors and brightness);
6-AR-ML (+++) - The architecture should allow that the **upgrade and configuration** of a mobile learning environment can be performed a simple and automatic way, avoiding errors by users;
7-AR-ML (++) - The architecture should allow the m-learning environment can **synchronize and coordinate** its information with other mobile devices, allowing to the users the independence on these devices;
8-AR-ML (+++) - The architecture should support/enable the development of m-learning environments that provides **portability in relation to mobile devices** without the need to apply other actions (settings);
9-AR-ML (+++) - The architecture should support/enable the development of m-learning environments that provides features to **improve the social interaction** among users;
10-AR-ML (+++) - The architecture should support/enable the development of m-learning environments that provides **adaptation to the context**, ensuring adaptation to the user´s context in relation to physical, social and timing issues, among others.
11-AR-ML (+++) - The architecture should support/enable the development of m-learning environments that **allow collaboration among users** through wikis, forums, microblogging, social networks, among other tools.

4.3 Architectural Requirements Specific to SOA

1-AR-S (+++) - The architecture must **provide mechanisms for capturing, monitoring, registering and notifying** the non-compliance of quality requirements established among service providers and service customers;

2-AR-S (+++) - The architecture should enable the development of **scalable** educational environments, **capable of evolving incrementally** through the addition of new services;

3-AR-S (+++) - The architecture should allow the educational services that can be **treated uniformly**, i.e., can be published, located and used in the same way;

4-AR-S (+++) - The architecture should support the development of learning environments that **provide information about their characteristics and normative directions of use** through standardized descriptions;

5-AR-S (+++) - The architecture should allow that educational tools implemented in different programming languages and under different platforms **can be easily integrated**;

6-AR-S (+++) - The architecture must provide mechanisms for that didactic materials, as services, **can be published and discovered** by client applications;

7-AR-S (+++) - The architecture should allow that the educational services **can interact directly or through the use of an enterprise service bus**;

8-AR-S (+++) - The architecture should support the development of learning environments that **provide semantic descriptions**, allowing their classification in the service repositories;

9-AR-S (+++) - The architecture should support the development of learning environments that **provide information and documents related to their quality characteristics**;

10-AR-S (+++) - The architecture should enable that the mobile learning environments **communicate with other educational tools**;

11-AR-S (+++) - The architecture should allow **a partial instantiation**, that is, learning environments developed according to this architecture can be built without the need of implementing all the modules specified.

5. CONCLUSION AND FURTHER WORK

In this paper we presented a set of architectural requirements for service-oriented mobile learning environments. The requirements were elicited through a systematic process, taking into consideration: (1) application context definition; (2) the investigation of related work; (3) the analysis of existing mobile learning environments; and (4) the help/support of specialists to prioritize and complement the requirements. In the end, the proposed requirements were categorized in four groups of specific areas: (1) architectural requirements for learning environments in general; (2) architectural requirements specific for mobile learning environments; and (3) architectural requirements specific to SOA.

The main contribution of this work lies on providing guidance for architectural design of new m-learning environments as well as for evolution and maintenance of the existing ones. Indeed, the right definition of architectural requirements can promote a better abstraction of the system to be developed/evolved, helping its architectural representation. As a consequence, the determination of these requirements can provide benefits with regard to overall quality, interoperability, reuse, domain comprehension, and reduction of the time spent in the development/maintenance of m-learning environments. As further work, we intend to define a reference architecture for mobile learning environments. The architectural requirements defined in this paper will play a fundamental role in this direction, acting as the basis for the establishment of such architecture. We are currently working on this perspective; details should be reported in short term.

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PORTABILITY AND USABILITY OF OPEN EDUCATIONAL RESOURCES ON MOBILE DEVICES: A STUDY IN THE CONTEXT OF BRAZILIAN EDUCATIONAL PORTALS AND ANDROID-BASED DEVICES

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ABSTRACT

Open Educational Resources (OER) are freely accessible, openly licensed hypertext, audio, video, simulations, games and animations that are useful for teaching and learning purposes. In order to facilitate the location of such resources, educational content portals are being created, crowding contents that were produced by different teams with different technologies usually designed to be accessed by conventional computers equipped with keyboard, mouse and a medium-sized screen. Since these resources are available in Internet and with the popularity of smartphones and tablets it is necessary to study the portability and the usability of these resources when accessed by these devices, which user interact with fingers. Due the changing of the input modalities and other device´s characteristics some usability problems can occur and can impair the use of these resources in mobile devices. This exploratory study intended to raise and analyze possible difficulties of interaction between users and educational software designed for desktop accessed through mobile devices like tablet and smartphone. We discuss data about three educational resources accessed in two android-based mobile devices, a smartphone and a tablet, and identified several problems that resources´ developers need to take account to produce resource for be accessed in desktops and mobile devices and the problem of download and running OER on mobile devices.

KEYWORDS

Mobile devices; Open Educational Resource; Portability; Usability.

1. INTRODUCTION

Open Educational Resources (OER) are freely accessible, openly licensed hypertext, audio, video, simulations, games and animations that are useful for teaching and learning purposes. In order to facilitate the searching for OER, digital educational content portals are created to be a storage location for resources that were produced by different teams with different technologies usually designed to be accessed by conventional computers. The Brazil´s Ministry of Education (MEC) created some portals such *RIVED*, *Portal do Professor* (Teacher´s Portal) and *Portal International de Objetos Educationais* (International Database of Educational Objects) portals and it is encouraging the development of resources through partnerships with Brazilian´s educational institutions. One of the requirements is portability among many desktop´s operating systems; so, developers used formats that are not platform-dependent.

Mobile devices, such as smartphones and tablets, are becoming increasingly popular; most of them have touch screen displays, are easy to carry, have autonomy for hours, Internet access and enough computing power to process Web pages, audio and video files. So, it is possible access OER, initially developed to be used with keyboard, mouse and a medium size display, by touch screen devices. And this is expected to happen; most users say they would like to see more content for access by mobile, and given the growing use of smartphones and access to applications for these devices, it is expected that students use these resources in their learning activities, increasing the number of people who benefit from m-learning (mobile learning), the use of mobile devices to support learning. Thus, it is necessary to study the portability and usability of OER when they are accessed by mobile devices.

With this motivation, we studied the portability and usability of six OER available at Brazilian educational portals accessing them by two android-based devices, a smartphone and a tablet. Here we present the three most significant cases. Some questions that guide this work: Are the applications and content available on the portals of educational resources portable to mobile devices? What is the impact of access this content originally developed for desktop computers in smartphones?

As results we found restrictions of use of a set of OER available on the portals and some problems that were used to generate some guidelines for development teams. In Section 2 we presented some related work. Section 3 and 4 we presented the used materials and method and analyze of the collected data. In Section 5 we present the conclusion.

2. RELATED WORK

Nielsen (1993) defines the general acceptability of a system, composed by social acceptability and practical acceptability. One of the concepts that compose the practice acceptance is the "usefulness", which refers to the system can be used to achieve a particular objective. This concept consists of the usefulness and usability. Usability is a combination of five elements: ease of learning, efficiency, ease of remember, probability of the user making few errors and user satisfaction.

Norman and Nielsen (2010) commented about the disappearance of some fundamental design principles in touchscreen devices like iPad. These principles cited by Norman and Nielsen are technology-independent: i) visibility (a form of interaction adopted, such as a gesture on an object must be present in all parts of the application when the object is on the screen); ii) feedback (system offers an answer to the user action and the response returned by the system must be the answer expected by users); iii) consistency (in relation to interaction objects of the application, the platform and between platforms); iv) non-destructive operations (so it is important to have the functionality “undo”); v) discoverability (operation can be discovered through the exploration of menus); vi) scalability (the features should work in small, medium or large screens); vii) trust (the features must run and the events cannot occur randomly).

These problems and others related with portability and usability can be identified through an analysis of user interaction, using available (and validated by the literature) methods for evaluate the user interfaces. Methods to evaluate user interfaces can be categorized by inspection methods and empirical tests. Inspection methods involve usability experts whose advantages are low cost, rapid implementation and learning and efficiency to find errors and usability problems. The inspection methods are usually applied before other methods to complement the evaluation of the interface, as user tests. Empirical tests involve the participation of users and can be performed in or out the laboratory; usability problems can be identified by analyzing the user interaction or by a survey with questions about the use of the system.

In our previous work we studied the interactions of users performing tasks that required the use of some tools in the TelEduc Environment, whose design was developed for use in desktop computers with mouse, keyboard and a high resolution medium-sized screen, on three devices - desktop, a touch screen smartphone, and a touch screen tablet. We identified interaction problems and classified them into three categories: i) caused by modality changing; ii) caused by platform changing; and iii) those that are independent of platform or modality changing, but that could be identified due the use of more than one device. Here, in this paper, we focus on OER instead of an e-learning environment, but the approach is similar.

Similar with e-Learning environments, most of OER were developed to be accessed by desktop computers equipped with keyboard, mouse and high resolution medium-sized screen. When change the platform or the modality (from mouse plus keyboard to touch) some interaction problems happen.

The International Database of Educational Objects portal is a repository created in 2008 by the Brazil´s Ministry of Education (MEC), in partnership with the Brazil´s Ministry of Science and Technology, the Latin American Network of Educational Portals (RELPE) and the Organization of Ibero-American States (OEI). This portal, integrated with Teacher’s Portal, offers free digital objects such as videos, audios, images, educational games and software, animations and simulations from primary school to higher education levels. The portal offer statistics about the objects and describe that, in 2013, there are 5,926 simulations, 4,304 video files, 3,613 images, 3,067 audio files, 1,759 experiments, 794 educational software, 240 hypertext files and 21 maps.

In the International Database of Educational Objects portal there are 10,221 objects for college level, 9,200 for high level, 5,048 for basic education, 851 for childhood education and 483 for professional education. There are 4,562 objects about Mathematics, 3,223 about Physics, 2,089 about Chemistry, 1,576 about Biology, 1,438 about Foreign Language (e.g., English and Spanish), 1,420 about Portuguese and others courses.

One important requirement of OER is be usable in many contexts, and so different platforms. Most of resources developed with Brazilian´s Ministry of Education founding must be developed to be available at Internet and run in Windows and Linux; so, portability between operating systems is required. To meet this requirement, developers have used technologies such HTML, JavaScript, Java, MPEG, MP3, AVI, JPG, GIF, PDF and Flash. Most of resources cataloged as Video are available in MPEG format. The resources cataloged as Audio are available in MP3 format. Images and Maps resources are in JPG format. For Educational Software, Animation/Simulation some are in Flash format, but there are resources developed in Java or in EXE format.

We consider portability problems as problems that are discovered during interaction with the mobile device and do not occur in the interaction performed in the desktop. We consider problems related with the response time (performance) as portability problem too.

3. MATERIALS AND METHOD

The materials used were: OER available at Brazilian portals; a Smartphone Motolora Milestone 1 with Android version 4.1.1; and a tablet Positivo. The tablet used in the session tests is a Brazilian Positivo Ypy, 1.0 GHz ARM Cortex A9 processor with 1 GB RAM and a 10in multi-touch screen 800 x480 pixels of resolution with Android operating system version 4.1.1. The smartphone used in the session is a Motorola Milestone which has a 600 MHz Cortex-A8 processor with 256 MB RAM and a 3.7in multi-touch display 854 x 480 pixels of resolution and Android version 4.0.3 as operation system.

The chosen OER need to run on mobile devices (be portable from desktop to mobile devices) for identify interaction problems and related them with usability. Since our work focused on interactivity, we searched for OER where the number of interaction between user and resource is higher and not limited in reading and forward or backward the screen. So, resources catalogued as images, maps, videos and audios are not analyzed; even though the content in these categories are portable for mobile devices, as described on Section 2. So we focused our efforts on OER catalogued as Animation/Simulation and Educational Software. In this case, the portability is related with the format; EXE files have low portability because just work on Windows operating system family. Java programs have a better portability, working on Windows and Linux operating systems, but not all mobile devices platforms support Java, some of them support Java ME, a special edition of Java for mobile devices. But Android-based mobile does not support directly Java Me applications, need some conversion. Some OER were developed using Flash Technology, running on Windows and Linux operating system after the installation of a free plugin to run Flash files. Flash files can run in Android-based devices because the Macromedia released a plugin for Android; one of our motivation to use Android-based devices. Since there is not Flash plugin for iOS operating systems, it is not possible to run Flash applications on iPad or iPhone.

4. DATA ANALYSIS

The first resource evaluated was the "*Propriedades das emissões radioativas: poder de penetração*" (Properties of radioactive emissions: power of penetration), available at the International Database of Educational Objects and the RIVED Portal and classified as animation/simulation. This simulation is for college students and the educational goals are: i) teaching the power of penetration of radioactive emissions alpha, beta and gamma; ii) recognizing that the power of a particle´s penetration is related to its energy; iii) establishing a relationship between the power of penetration and possible damage to living beings; and iv) forms of protection. Fig. 1 shows some screenshots of the resource executed in a desktop computer on Firefox browser. The simulation begin within an explanation about the radiation and how it is dangerous for living beings (Fig. 1a); after the end of the explanation the equipment is presented, which is composed of electrified plates, a box of lead and isotopes. The user can know the components´ name through a message balloon that is displayed when the mouse pointer is over the component. Clicking in the box of lead, the experiment screen is displayed (Fig. 1b), where the user can chose an isotope (in the left), putting it inside the box of lead (top), select materials for experiments such as paper sheet, aluminum sheet, lead sheet, aluminum plate, wood plate, steel plate, lead plate, concrete block and human hand (in the screen bottom, selecting the option materials for the experiment). After choosing the isotope and up to three materials experiment, the user can open the lead box touching the black plate for radiation get out. According the isotope alpha, beta or gamma rays will be issued. In the bottom of the left-side there is a button that displays some questions to be answering (Fig. 1c). An usability evaluation running the OER in a desktop was done, and the following problems are identified: i) knowing which objects are clickable in the experiment screen (the only way is put the mouse pointer over and see if the pointer change); ii) when the user change the isotope, all materials are removed and need to be selected again; iii) it is not possible to change the order of the materials without remove them and adding one by one in the desire order.

In the Fig. 2 are showed the same screens but running the OER in the Android-based smartphone. It is noticed that the position of the interface elements continues with the same appearance and location, which, in terms of usability, it is positive because maintain the consistence. However, after the test case, it was possible to identify some usability problems that occur when run this OER on mobile devices, such as: i) the font size could be higher on mobile devices; ii) difficulty in opening the black plate that closes the lead box using the finger (it was easily accomplished through the mouse pointer on the desktop); iii) some plataform characteristics are not respect; e.g., to change pages in a mobile reader application the user just touch the screen and move the finger for left or for right. In the explanation screens it is not possible to use this gesture to go to the next text.

(a) (b) (c)

Figure 1. Educational simulation resource “Properties of radioactive emissions: power of penetration” executed in a desktop computer on a Firefox browser: (a) home screen with explanation; (b) laboratory screen to perform experiments; (c) screen with question to answer.

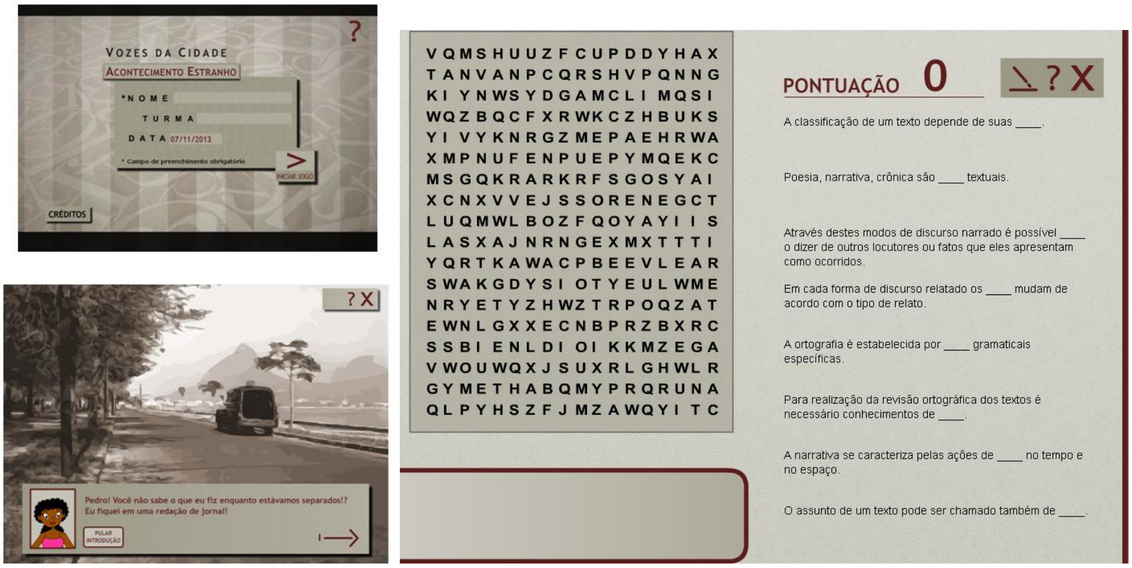
(a) (b) (c)

Figure 2. Educational simulation resource “Properties of radioactive emissions: power of penetration” executed in an Android-based smartphone: (a) home screen with explanation; (b) laboratory screen to perform experiments; (c) screen with question to answer.

Another identified problem is related with the devices; since the smartphone (and tablets too) does not recognize the finger proximity (they only recognize the touch), the user could have problem in interact with elements which have features triggered by mouse pointer over, such as interact to know the name of the laboratory components. This problem was attenuated because few objects in this resource have a feature triggered by mouse pointer over and another feature triggered by clicking; in components where there are different features triggered by mouse pointer over and by clicking, the ballon with the component name is display, but the screen is changed so fast that it is not possible to read the component name.

In the tablet, a device with a medium-sized screen, the font size is adequade for reading, the response time was considered appropriate, but i) the mouse pointer over problem occur; ii) there is not possible to navigate through the explanations using gestures; iii) the resource does not consider the rotation screen, working only on landscape format. All resources analyzed and developed in Flash, described below, have this problem in common.

The second resource evaluated was "*Programa Vozes na Cidade – Acontecimento Estranho*" (Voices of the City Show – Strange Event), a word search game catalogued as simulation/animation about grammar, showed in Fig. 3. The game goals are: i) observe the different ways of moving an idea indirectly; ii) analyze various texts from its textual organization; iii) reflect upon the orthographic norms; iv) analyze the different stages of text production, with emphasis on the review; v) analyze the different ways that speech can be: direct speech, indirect and free indirect; vi) analyze the textual significance considering its inhomogeneity; vii) analyze of the various stages of production of a newspaper.



(b) (c)

Figure 3. Educational resource "Voices of the City Show – Strange Event" executed in a desktop computer: (a) home screen; (b) introduction screen; (c) the word search screen.

(a) (b)

Figure 4. Educational resource "Voices of the City Show – Strange Event" executed in an Android-based smartphone: (a) home screen with the virtual keyboard over the form; (b) the word search screen.

The home screen (Fig. 3a) shows the name of the application with three fields (to fill with the name, class and date, but only the name is required). At the top of the right side we have a question mark to access the tutorial; this element can be accessed on all screens of the game. After fill the form and press the button to start the game ("*Iniciar Jogo"* button), an introductory history is presented (Fig. 3b); the user can read the text, a conversation between two personages, or skip this presentation. The next screen (Fig. 3c) presents the place where the user needs to find the words (left side) that are missing in the phrases (right side). When the user identifies a word and select it clicking in the first letter and moving the mouse pointer to the last letter (or vice versa), the word will be showed in the box below the search word place. So the user can drag and drop the identified word putting in a blank space. The user earns points when she hit the space for the word, and loses if she put in the wrong space. At the end, or clicking in the pencil icon at the top of the screen, a report is displayed.

In the tablet few interaction problems are identified. One was related with the performance, a little more slow and difficult to select the word, because the user finger is on the letter, blocking the user see if no other letter was included by mistake. Another problem is when the user will fill the form the virtual keyboard takes up part of the screen covering part of the fields; similar has happed on the smartphone (Fig. 4a).

Another problems was identified when executed the OER in the smartphone: i) the user have difficult to read the phrases and ii) to select the found word, a very difficult goal to perform due the size and the finger over the letters, so difficult that it is very hard to mark a word. Maybe using a zoom feature can decrease the severity of these problems, but this feature is not implemented in the application either in the Flash player. It was detected a performance problem when the user drag the found word and drop it in one of the blank spaces. To reach the goal the user needs to wait some time before release the word over the blank space.

The third analyzed resource was "*Causos e Falas – Episódio 3: A chegada do filho*" (Stories and Speeches - Episode 3: The arrival of son), catalogued as simulation/animation, that the user needs to interact with personages and answer questions. For each correct answer the user wins an object that can be used to construct a cartoon. The resource goal is check understanding of preconceptions of language, realizing that the Portuguese language was influenced by the words of other languages. This resource is very similar as the last one, with a form in a home screen with three fields (to fill with the name, class and date, but only the name is required) (Fig. 5a) and an introduction text (Fig. 5b). After the introduction text, it will be displayed the party environment (Fig. 5c), where the user can select some personages to interact (only with personages whom have a balloon near), or navigate between the house clicking in the blue arrows. If the user reaches the end of the room, the respective blue arrow disappears to avoid the user to do a command without result. When the user clicks on a personage with balloon a text will be presented and after a question about it (Fig. 5d). In the smartphone the text is legible; the font size is not too small. One usability problem found is that the blue arrows do not be hidden when the user reach the end of the room; so in the smartphones the user can think that are more space and try to move again (Fig. 6). Another identified problem is to trigger the buttons due their size.

4.1 Discussion

We noticed that the position of all OER´s interface elements continues with the same appearance and location, which, in terms of usability, it is positive because maintain the consistence.

(a) (c)

(b) (d)

Figure 5. Educational resource "Stories and Speeches - Episode 3: The arrival of son" executed in a desktop computer: (a) home screen; (b) introduction screen; (c) the party environment screen; (d) the question screen.

Summarizing, a total of 10 problems are described in the three analyzed OER: i) the font size is to small to read on smartphones; ii) difficult to trigger features in elements with small height or width; iii) some plataform characteristics are not respect, e.g., use of gesture; iv) problem to trigger mouse point over interactions; v) the resources do not consider the rotation of the screen, working only on landscape format; vi) low performance in some devices; vii) virtual keyboard or other platform element can cover part of the resource screen; viii) the finger can obstruct user vision when she touch the screen; ix) it is not possible to use zoom; x) elements cannot have the expected behavior when is associated with other changing (it is necessary to analyze the code to confirm this hypothesis).

We believe that most of them are not a barrier for the use, but can prejudice the learning process, since can get the user nervous or anxious due the lack of performance or efficiency (many tries is necessary to trigger the action) and, sometimes, the text are too small and it is not possible to use zooming features. Some studies with volunteers answering satisfaction questionnaires can aim to probe this relation.

Based on these results, we identify two classes of problems related to portability: i) technical problems related with the device characteristics, such as the performance; ii) integration problem between the technology used to develop the resource (Flash), the Flash plugin to execute the file and the operating system (Android) that does not reflect the action of pinching fingers. The second category of problems cause strangeness with mobile users which make constant use of the feature (e.g., zooming), since she will be unable to identify the cause of the non-functioning in this particular context.

(a) (b)

Figure 6. Educational resource "Stories and Speeches - Episode 3: The arrival of son" executed in an Android-based smartphone: (a) the party environment screen; (b) the question screen.

Even in Android-base device is not easy to run an OER developed in Flash. The user needs to install the Flash plugin and a player application. The user can use the player application and select the Flash file or use a file browser application to go to the folder and execute the correct file. Before the select the OER to run, it is necessary to download de OER file and extract it, since most of the content available at the studied portal are compacted. So an application to extract the files needs to be installed too. These steps can be difficult for mobile users, since the model of trigger applications in mobile phones is very different. Mobile users use specific application (e.g., Play Store in Android) to search and install new applications.

5. CONCLUSION

Open Educational Resources (OER) are freely accessible, openly licensed hypertext, audio, video, simulations, games and animations that are useful for teaching and learning purposes. In this paper we analyzed three educational resources catalogued as simulation/animation and accessed them in two Android-based mobile devices, a smartphone and a tablet, to identify problems that resources´ developers need to take account to produce resource for be accessed in desktops and mobile devices. More three resources were analyzed but, due the limitation of pages, we presented the most significant ones.

In our research we found problems related with performance, text legibility and trigger actions in small objects. Other identified problems are related with the finger covering part of the screen and in the object that have features triggered when the mouse pointer is over. Lack of integration between the application and the mobile devices was detected: gesture and rotation do not work.

It is important to consider that the input modality is different between desktops (keyboard + mouse) and mobile devices (touch screen) and this changing impact on the user satisfaction. The two volunteers related that the OER they liked least was Voices of the City Show – Strange Event, the second OER presented. The reasons were: i) the small screen turning hard to read and to select the words, and ii) low performance in the smartphones. The volunteers point out that this OER was the most difficult to play. To increase the adoption of educational resources in mobile users we believe that, beyond identify and mitigate usability problems, the search mechanism of content portals needs to be closer to the model adopted in mobile devices for install new applications and a mechanism to easily run the resource.

Future work will be analyzing the collected data collating with the concept of Responsive Design (Marcotte, 2011), mainly investigate the relation between the input hardware and the guidelines proposed by Responsive Design literature. Responsive Design can aim multi-devices OER giving the user an optimal viewing experience but the interaction goes beyond; it is necessary to consider the input hardware. We were interested in study which technologies make the OER support many input modalities.

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EVALUATING QR CODE CASE STUDIES USING A MOBILE LEARNING FRAMEWORK

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ABSTRACT

The aim of this study was to evaluate the feasibility of Quick Response (QR) codes and mobile devices in the context of Finnish basic education. The feasibility was analyzed through a mobile learning framework, which includes the core characteristics of mobile learning. The study is part of a larger research where the aim is to develop a theoretical framework for mobile learning and mobile learning practices. QR codes were chosen in particular because teachers were interested in seeing how this relatively easy and versatile technology could be utilized in their classrooms. QR code implementations blended in and enriched the traditional teaching methods and classroom learning in a motivating and meaningful way. The core characteristics of mobile leaning were realized comparatively well. However, the study also indicated that the factors that should be added to the framework are the school curriculum, ICT integration strategies, teacher competencies, and technological, social and cultural change.

KEYWORDS

Mobile learning, mobile learning framework, pedagogical practices, Quick Response (QR) codes.

1. INTRODUCTION

Old Chinese proverb advises: *"Tell me and I'll forget. Show me and I may remember. Involve me and I'll understand"*. One globally increasing trend and an efficient way to involve learners is mobile learning, which can be understood as learning with mobile devices in various contexts (O'Malley et al., 2005). There is a consensus among the researchers that mobile technologies have great potential to improve teaching and learning. However, the concept of mobile learning is still developing rapidly and a cohesive theoretical mobile learning framework is missing.

The present paper focuses especially on the process and impact of implementing Quick Response (QR) codes and mobile devices in the context of Finnish basic education. The aim of the study is to evaluate QR code case studies by using the mobile learning framework. The study is part of a larger research where the aim is to develop a theoretical framework for mobile learning as well as tools and practices for the educational use of mobile technologies.

The study of QR codes in education can be placed in the context of mobile learning. At best, mobile technologies, such as QR codes, facilitate learning outside of classroom and learning materials are no longer limited to textbooks (Shih et al., 2011). There is a variety of ways to use QR codes in educational context (Rikala & Kankaanranta, 2012). In this study, teachers were cooperating in developing new ways to embed QR codes in learning.

The feasibility of the QR code implementations was evaluated through a theoretical framework, which includes the core aspects of mobile learning. The study advanced the two most recent and extensive frameworks introduced by Koole (2009) and Kearney et al. (2012) as a basis of the theoretical framework. The characteristics discovered in the QR code case studies could be used to develop the framework further.

This article is organized as follows: first the theoretical background is discussed, which is followed by experimental investigations and results, and concluded with reflective remarks.

2. THE MOBILE LEARNING FRAMEWORK

In recent years, mobile devices have become an important part of everyday life. Improvements in mobile devices have made them appropriate for educational use also, and mobile technologies have promoted a new learning style known as mobile learning. Mobile learning in itself has a surprisingly long history (Naismith & Corlett, 2006): while its roots are in the 1970s, its popularity did not peak until in the 2000s (Lam et al., 2010). Despite the relatively long history, mobile learning is evidently undeveloped compared to other technologies and their pedagogies (Traxler, 2007). Thus, mobile learning has not yet reached a stable form and the concept of mobile learning is still developing rapidly (Lam et al., 2010).

Many researchers have attempted to encapsulate the unique characteristics of mobile learning in the form of a simplified framework (e.g. Parsons et al., 2007; Koole, 2009; Nordin et al., 2010; Ozdamli, 2012; Kearney et al. 2012). However, all these frameworks emphasize different characteristics and a cohesive theoretical framework is still missing. The lack of a cohesive theoretical mobile learning framework and mobile learning standards have led to a situation in which the mobile learning pilots and trials are characterized by short-term and small-scale studies focusing on either user acceptance or attitudes (Rushby, 2012). Consequently, one major challenge is that mobile learning solutions are not deeply-rooted in educational contexts or in practices. Without a cohesive framework, it simply takes too much of the teachers' time and energy to interweave all crucial aspects together. In other words, there should be a framework that would help the move from theory to practice.

As teachers alone will be unlikely to bring about the width of implementation needed, this study argues that there is a need for a theoretical framework that takes into consideration the core characteristics of mobile learning as well as pedagogy and that all these aspects can explain the process that can at best lead to a pedagogically sensible and sustainable way to utilize mobile technologies in educational contexts. In other words, at best the framework can help in planning, implementing, evaluating and developing mobile learning and its solutions.

In this study, the core aspects identified by Koole (2009) and Kearney et al. (2012) in their respective frameworks provide an evaluation framework in which the feasibility of the QR code implementations is analyzed. These frameworks introduced by Koole (2009) and Kearney et al. (2012) suggest that mobile learning has certain elementary characteristics that separate it from other types of learning. Koole (2009), for instance, described mobile learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction. Learners may move within different physical and virtual locations and participate in and interact with other people, information, or systems. In other words, three aspects − the device, learner and social aspects − are intersecting. The framework introduced by Kearney et al. (2012), in turn, includes three core characteristics: 1) personalization, 2) authenticity, and 3) collaboration. The personalization has implications of ownership, agency, and autonomous learning; the authenticity highlights the opportunities for contextualized, participatory, and situated learning; the collaboration captures the conversational and connected aspects of mobile learning. The way learners experience these characteristics is strongly influenced by the organization of the spatial and temporal aspects of the mobile learning environment.

Based on these two frameworks, an evaluation framework was developed. The evaluation framework includes/consists of two levels (see Figure 1) titled core level and medium level. The core level and medium level are explained briefly below. Mobile technologies have a unique ability to support learning anywhere anytime. For example, mobile devices can expand the learning environment to authentic contexts such as parks, museums, and nature. Therefore, the aspects such as context, time and space form the core of mobile learning (see Figure 1). Many researchers (e.g. Silander and Rytkönen, 2005) have stressed that the mobile learning process should be as authentic as possible. For this reason, authentic contexts and real-life problems are considered important. At best, mobile technology can extend the learning environment into authentic contexts and provide a variety of stimuli, schemas, and techniques, and extend learning beyond the traditional learning space in a motivating way (Naismith et al. 2004; Rikala and Kankaanranta, 2012).

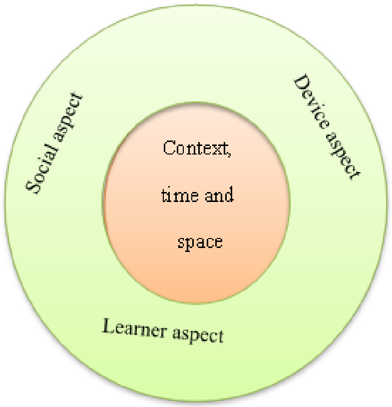

Figure 1. Core characteristics of mobile learning.

The other important aspects of the mobile learning process are the learner aspect, device aspect and social aspect. These aspects form the medium level of the mobile learning framework (see Figure 1). An Individual learner's cognitive abilities, memory, emotions, motivation, attitudes, and experiences are in a significant role in the learning process and thus in the mobile learning process as well. For this reason, it is important to understand the learners' needs and the factors that are influencing their learning (e.g., the current level of knowledge, attitudes, experiences, and motivations). In other words, the learner should be placed at the centre of the learning process (Ozdamli and Nadire, 2011; Zhang et al., 2010).

On the other hand, the device aspect should not be forgotten either. Despite the fact that mobile devices by themselves do not guarantee enhanced teaching or learning, technological decisions are also important when mobile learning activities are being planned. In the device aspect, especially device usability is emphasized. The device usability involves the physical, technical and functional characteristics of a mobile device and applications that influence for instance the learner's experience, perceived ease of use, and perceived usefulness. The learners' motivation can suffer and they become frustrated if they encounter problems with technology (Rikala and Kankaanranta, 2012). For this reason, it is important to choose easy-to-use devices that have sufficient capabilities and, if at all possible, try to identify and limit errors in advance.

Social aspect's importance as a part of the learning process cannot be underestimated (Koole, 2009). Different kinds of interactions can stimulate learning (e.g. learner-learner, learner-instructor, learner-content, and learner-technology). For this reason the relationships and interaction with other learners, experts, systems and contents should be considered; how the use of mobile devices might change the process of interaction between learners, communities, and systems? Therefore, the process of mobile learning is defined and continuously reshaped by interaction between the learner, device, and social aspects (Koole, 2009). At best, mobile devices can enhance and encourage social interaction with the instructor and peers (Rikala and Kankaanranta, 2012). From the learner's point of view, it is also important that they receive sufficient feedback and guidance during the process. This kind of support can increase the learner's confidence and competencies as well as help them overcome any arising difficulties (Nordin et al., 2010).

3. RESEARCH DESIGN

This study reports the findings of two QR code case studies conducted in schools in Central Finland in the autumn of 2012. The case studies were part of the Personal Mobile Space project funded by Tekes (the Finnish Funding Agency for Technology and Innovation) and led by Professor Pekka Neittaanmäki and Marja Kankaanranta from the University of Jyväskylä (see Kankaanranta, Neittaanmäki & Nousiainen, 2013).

The use of a case study method is appropriate because it provides in-depth examination and gives an understanding of the perspectives, opinions, and expectations relating to smart phone usage and QR code activity and thereby also brings new perspectives and aspects to the mobile learning framework.

A group of interested volunteer teachers developed new ways to embed mobile technologies and QR codes in learning in cooperation. QR codes were chosen in particular because the teachers were interested in seeing how this relatively easy and versatile technology could be utilized in their classrooms. The research data was collected with multiple data collection methods; observations, student surveys, and teacher interviews. The questionnaire and interview questions were designed to cover the core aspects of mobile learning as well as to measure and understand the perspectives, opinions, and expectations of smart phone usage and QR code activity. Below, two QR cases are briefly described.

Table 1. QR code cases.

Case	School	Sample & Grade level	Equipment
Math trail	Primary school	Twenty-four 5th grade students (aged 10-11 years)	Provided by the researchers
Literature tree	Secondary school	Sixteen 9th grade students (aged 14-15 years)	Provided by the researchers

Math trail – In the primary school, a Math Trail was conducted for 5th grade students (aged 10-11 years). The overall objective of the activity was to enhance the students' mathematical skills and to bring much-wanted variation to the school day. The learning subject and objective of the experiment was to learn about decimal numbers. The math trail was located in the school surroundings – e.g., corridors, classrooms, and furniture. At the beginning of each math lesson, the teacher taught the theory and the students solved five problems from the textbook. After solving textbook problems, the students could go circulating the math trail. During the math trail experiment, each student had one loaned smart phone and a map of the trail including QR code locations given to him or her. For each QR code location, the students answered one problem by scanning the code and submitting their answer using an online form on the mobile device. If the answer was correct, the student received a hint on the following QR code location. The math trail included a total of 65 decimal number problems (textbook-like).

Literature tree - In the secondary school, a Literature tree activity was conducted for 9th grade students (aged 14-15 years). The overall objective of the activity was to revise the lessons learned earlier about Finnish literary history. The literature tree activity was located in the school surroundings – e.g., corridors, statues, and paintings. The activity included a "literature tree", a kind of a map where the students were asked to place certain concepts in the right places. The students circulated around the school in small groups and tried to find QR codes which contained the hints. The QR codes contained for instance weblog texts and pictures, which helped the students to place the concepts in the right places in the literature tree map.

4. FINDINGS

The two QR code case studies were evaluated through a mobile learning framework (see Figure 1). The core level aspects, medium level aspects as well as other emerging aspects are described in the following Chapters.

4.1 Core Level Aspects

The context where the mobile devices and QR codes were used was interspersed with traditional classroom learning. The students were able to work at their own pace and in the ways that they preferred. However, the time when the mobile devices and QR codes were used was specifically planned and consequently the activities were not spontaneous situations. QR codes were placed around the school surroundings, so in other words learning was extended outside the classroom. However, at best, these kinds of implementations could be arranged in authentic real-life contexts where students could discover and solve problems relating to what they find.

4.2 Medium Level Aspects

The other important aspects of the mobile learning process are the learner aspect, device aspect, and social aspect. These aspects form the medium level of the mobile learning framework. The results of these aspects are described in the following sub-Chapters.

4.2.1 Learner Aspect

In both cases, students were very curious about the new approach that deviated from their routine exercises. In other words, QR codes had a stimulating effect on learning. In primary school, all students agreed that QR activities were an interesting and exciting way to learn mathematics and that they would like to do QR activities again. All the students also found new teaching and learning methods more attractive than the traditional ones. Based on the survey, the new way to learn mathematics inspired and motivated boys in particular but also girls were engaged and claimed that QR codes made decimal problems somewhat or a lot more interesting. In the secondary school, the experiment divided student opinions. 75% of the students agreed that QR activities were an interesting new way to learn and over half (63%) of the students would like to do them again. 50% of the students found new teaching and learning methods more attractive than the traditional ones. However, some of the boys commented on the experiment in a negative tone. Also the observations during the experiment indicated that some boys' attitude was negative and that they were more interested in what else could be found on the phone. These negative feelings were probably the reason why girls claimed more often than boys that QR codes made literature history tasks more interesting.

In the primary school, the teacher was satisfied with experiment. She commented that the math trail inspired and motivated students. She presumed that the students' motivation derived from the autonomy as the learners could have control over the pace at which they learned and were able to solve the challenging tasks in an interesting way instead of through the traditional textbook learning. However, according to the students' feedback, there should be a wider range of math problems, as two students found the problems too easy. Another student commented: "The QR codes were an interesting new way to learn, but the math problems could have been more difficult." According to the teacher interview, the math trail served most of the students' needs but two students couldn't participate because they received remedial or special needs education in mathematics. The QR code activity was too difficult for these two students. The teacher commented: "It did not occur to me when we were planning this Math Trail that these two pupils would not be able to participate because they progress slower. In retrospect, there should have been even more variation in the math problems. Now there was quite a strong dissimilarity experience for these two pupils and that was not good." In other words, by providing a wider range of tasks, the math trail could be personalized in such a way that it would better serve different types of learners and even students who receive remedial or special needs education. In this experiment, however, the special needs of the two students were not taken into account adequately in the planning process.

In the secondary school, the teacher and two teacher trainees who participated in the experiment argued that QR codes can attract and serve a wide range of learners. The activity offered many opportunities for personal instruction but they were not utilized. Another teacher trainee commented: "One major aspect that was missing was proper feedback. In these kinds of trials there should be much more time for feedback and the way feedback is given should be planned beforehand." The lack of sufficient feedback and guidance led to a situation where the students perceived the trail more as a competition than a learning task.

4.2.2 Device Aspect

In both cases, there were some challenges with the devices. However, no major technical problems occurred during the experiments. The problems that were reported and observed were mainly caused by the QR code decoding software. In the future, it would be reasonable to test various QR code readers.

In the primary school, the students strongly agreed that it was easy to use QR codes (100%) but somewhat disagreed that the QR code scanner always functioned as they expected (61%). Only 26% of the students had used QR codes before the experiment. This can be one reason why students experienced problems. Another problem is related to the QR code scanner itself. The software that was used for decoding the QR codes was slightly unsteady and some students grew impatient with it. One student for instance wrote "The math trail activity was fun, but sometimes when I was scanning the code, the code reader became blurry." Another student wrote "It zooms by itself and that was annoying."

In the secondary school, the students strongly agreed that it was easy to use QR codes (94%) but somewhat disagreed that the QR code scanner always functioned as they expected (56%). Only 38% of the students had used QR codes before the experiment. This might be one reason why some students experienced problems with the QR code scanner. Even though mobile devices and their use are familiar to the students the scanning of the QR codes raised a lot of questions. During the experiment, one student for instance asked: “Oh, does it take the picture automatically?” Another student asked: “Should I take a picture?” Another problem was again related to the QR code scanner. Observations made during the experiment indicated that the QR code scanner was unsteady. One student for instance commented during the experiment: “This is not working. This is fuzzy. What on earth...”

Furthermore, the scanning of QR codes could become more difficult depending on the circumstances. In the primary school, it was discovered that a rounded surface made the QR code scanning more difficult. Also lighting conditions can interfere with the scanning as the teacher reported that the students could not scan the codes if they were placed in a dark location.

Another considerable challenge was the loaned smart phones (Nokia 5800 XpressMusic). They are a few years old and utilized in several experiments, which clearly had an effect on their reliability. In the primary school, the students claimed that the smart phones did not always function as they expected: 61% of the students disagreed with the statement “The phone functioned as I expected”. According to the teacher the phones, however, functioned surprisingly well and the battery charge was running out or students reported problems only once or twice during the math trail. In the secondary school, nearly half (44%) of the students claimed that the smart phones did not function as they expected. Also observations made during the experiment indicated that there were some problems with the phones and especially with the data connection.

According to the primary school teacher, the students learned how to use the loaned smart phones and applications instantly. Few students had problems and needed help during the experiment. This is consistent with the survey results as only 13% of the students expressed that they had to learn many things before they could use the phone and QR code application and with the fact that mobile devices are familiar to students, as all students reported that they own a mobile device. Technical problems naturally had an effect on the students’ learning experiences but not inauspiciously, as all students would like to do QR activities again. One student commented when asked for an opinion about the experiment: “It was fun as you were able to use a phone.”

According to the secondary school teacher and teacher trainees as well as observations, the students instantly learned how to use the loaned smart phones and QR codes. This is also consistent with the survey results as none of the students expressed that they had to learn many things before they could use the phone and QR code application. Technical problems naturally had an effect on the students’ learning experiences but not inauspiciously, as 63% of the students reported that they would like to do QR activities again.

4.2.3 Social Aspect

The Math trail activity was planned to be a self-directed and independent activity, but cooperation was allowed. According to the teacher, the students regularly formed groups and solved problems together. The math trail activity encouraged social interaction. However, in this activity, mobile technology was not used to mediate collaboration and therefore the social aspect is slightly questionable.

In Literature tree activity, the students solved problems in small groups and, according to the observations made by researchers, actively advised each other when they encountered problems. Based on the observations, the Literature tree activity encouraged social interaction.

4.3 Other Emerging Aspects

Teacher interviews revealed several aspects that emerged from outside the framework. These were teacher competencies, ICT integration strategies, and technological, social, and cultural change. It is obvious that technological, social, and cultural changes do and will influence learning. These changes were mentioned in teacher interviews. One of the teachers for instance commented: “When you are considering this time and this life, then yes, you should include some good things into teaching as well.” Teachers mentioned that using technology as part of teaching makes students feel that teaching and learning are more present-day, making it easier for school to come closer to the students’ everyday life.

Teacher competencies were mentioned several times during the teacher interviews. One of the teachers commented: “If I was to take this kind of implementation as a teaching method, I should study more information technology.” Teachers’ opinions about mobile learning were very positive. They reported that the experiment extended their thoughts and that they had started to consider additional uses of mobile technologies in educational context. However, they all said that they would need more practicing. One of the teachers suggested that QR code activities and similar could be included in and enclosed with the textbook, providing an easy way for the teachers to organize mobile learning activities. It was also a big relief to the teachers that the students already knew how to use smart phones, allowing them to skip one major step, i.e., teaching students to use the devices. One major issue that came up in the interviews was the fear and anxiety that teachers need to overcome before they can start to utilize mobile technologies as a part of their teaching practices. One of the teachers commented: “It is like stepping away from your comfort zone. However, when you do it, you notice that actually you did not have to step away from your comfort zone at all.”

One obvious challenge in the implementation of mobile learning is, according to the teachers, the ability of the school to provide the necessary tools and devices. One teacher commented that schools should purchase equipment needed. She commented: “Some students have flashy devices but some only have standard phones, not even smartphones.” All the teachers also speculated about the abusive and disruptive use of the devices. One teacher commented that there should be some kind of restrictions to ensure the safe use of the devices. It was also mentioned that technology should not be used only because it exists but rather because there is a clear pedagogical meaning and reason for its use. All these comments are related to ICT integration strategies.

5. CONCLUSION

Based on teacher interviews, student surveys, and observations, the experiments indicated that QR codes provide motivating and meaningful experiences for students. Students were enthusiastic and motivated about the new approaches that deviated from their routine exercises. However, it is important to design activities well and take students’ needs into account. This was observed especially during the math trail experiment, where the special needs of two students were not taken into account adequately in the planning process. The learners’ motivation can suffer or they are not able to participate in the activities if their needs are not taken into account sufficiently. This highlights the learner aspect in the mobile learning process.

Both activities encouraged social interaction. However, especially in the math trail activity, mobile technology was not used to mediate collaboration and therefore the social aspect is slightly questionable. Also the device aspect was challenging as there were some challenges with the smart phones and especially with the QR code reader. The activity therefore clearly highlighted the need to test various QR code readers as well as to ensure that it is possible to scan QR codes without much effort.

The context where the mobile devices and QR codes were used was interspersed with traditional classroom learning and unfortunately the implementation situations were not as authentic and spontaneous as they at best could have been. One reason for this is that in both cases the activities needed to be relevant to school curriculum. Another reason was that the activities were not structured around authentic contexts or real-life problems. The study therefore indicated a need for widening the framework with characteristics related to school such as curriculum. In teacher interviews, there were also other aspects that were emerging from outside the framework. These were ICT integration strategies, teacher competencies, and technological, social, and cultural change. All these aspects should be added in the third level of the framework (the external level).

Based on the present findings, it seems that the appropriate way to utilize mobile applications in an educational setting requires a balance where technology use is matched with the curriculum, student needs, and human interaction; in other words, pedagogy. The pedagogical practices are, for instance, highlighted by Parsons et al. (2007), Nordin et al. (2010) and Ozdamli (2012) in their frameworks. Especially, in QR code activities, the teacher’s contribution is significant, as they plan the situations in which the QR codes are used and define the targets and contents of learning as well as the ways used by the learners to utilize mobile technology in order to achieve these targets. As QR codes were new to teachers and as the cases were their very first mobile learning implementations, it is self-evident that all of the aspects in the framework were not fulfilled satisfactorily. More mobile learning case studies are needed to verify the aspects. Nevertheless, the study provides a good basis for continuing research on the educational use of QR codes and constructing and reconstructing a theoretical framework for mobile learning.

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DEVELOPING A MOBILE SOCIAL MEDIA FRAMEWORK FOR CREATIVE PEDAGOGIES

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ABSTRACT

This paper explores an overview of an evolving framework to enable creative pedagogies as applied to three different higher education contexts. Based upon our experiences, we propose a critical framework for supporting and implementing mobile social media for pedagogical change within higher education. Our framework maps the SAMR educational technology adoption framework with three levels of creativity onto the Pedagogy-Andragogy-Heutagogy continuum. We illustrate the use of this framework in the context of three University courses: Communications Studies, Journalism, and Graphics Design. Critical to the framework is the establishment of collaborative communities of practice of lecturers and educational researchers who model the use of mobile social media in their own teaching practice. Implementing our framework has enabled a refocus upon ontological pedagogies rather than previous teacher-directed pedagogies.

KEYWORDS

Communities of practice, mobile, social media, heutagogy.

1. INTRODUCTION

Design and arts education seeks to generate graduates who can think creatively and become active participants of the community of practitioners associated with their chosen field of design. Supporting creativity involves a range of activities and pedagogical approaches.

> Creativity thrives in an atmosphere that is supportive, dynamic, and receptive to new ideas and activities. The learning environment has to encourage interactions between learners in which: action and reflection are carefully counter-balanced; open-ended periods of play and 'blue-sky' thinking alternate with goal-oriented problem-solving; stimulating inputs and staff interventions are interwoven with periods in which learners develop ideas and constructs at their own pace; critical thinking and robust debate co-exist with a supportive 'space' in which risk-taking, imaginative exploration and productive failure are accepted as positive processes of learning and, the development of meanings and interpretations is inseparable from material processes and production. (Danvers, 2003, p52)

Thus the creative professions, including the many fields of design, typically require a holistic approach to education focusing upon the learner becoming part of a professional community, involving the dimensions of knowledge, performance and 'learning to become' (Danvers, 2003, pp53-54).

In order to transform students into creative professionals, educators' need to focus upon ontological pedagogies that deal with the process of becoming, rather than pedagogies that focus upon knowledge transfer. This approach could also be extended to other fields. In today's world where the most ubiquitous technology is mobile (ITU, 2011) and mobile internet connectivity exceeds fixed connections, education must include a critical engagement with new technologies including mobile social media.

> Having started as craft-based training with rather narrow vocational aims, design education is developing into an interdisciplinary academic field emphasizing research and preparing designers for a knowledge economy. (Yagou, 2007)

Mazur (2012) argues that lecturers are more effective when they focus upon interaction among students by producing active learners. This involves a reconception of teaching where the "focus moves away from the lectern and toward the physical and imaginative activity of each student in class" (Mazur, 2012). Mobile social media enables the design of learning activities that bridge authentic student learning experiences outside the classroom and the formal learning space of the classroom. We argue that mobile social media can be used as a catalyst to enable ontological shifts in pedagogy from teacher-directed paradigms to student-directed paradigms (Cochrane & Bateman, 2013). This involves modeling of the use of mobile social media as a creative tool by lecturers (Cochrane, 2012). Unfortunately the digital native fallacy has provided a convenient excuse for many lecturers to ignore their responsibility to engage with and model the use of mobile social media in teaching and learning. Prensky's (2001) notion of digital natives consisting of millennial students who are physiologically wired differently than previous generations of learners has been heavily critiqued (Sheeley, 2010). It has been subsequently argued that engagement with new technologies in learning is not age related (White & Le Cornu, 2011), but involves a conceptual shift in understanding of the roles of teachers and learners and the empowerment enabled by new technologies. Therefore we have found that we must begin by enabling an ontological shift in lecturers perceptions of the academic and creative use of mobile social media.

2. A FRAMEWORK FOR CREATIVE PEDAGOGIES

Both learners and teachers invariably default to using new technologies within the scope of their prior experiences. This results in what Herrington and Herrington refer to as the phenomena of one step forward for technology, but two steps back for pedagogy.

> Despite the significant potential of mobile technologies to be used as powerful learning tools in higher education, their current use appears to be predominantly within a didactic, teacher-centred paradigm, rather than a more constructivist environment. It can be argued that the current use of mobile devices in higher education (essentially content delivery) is pedagogically regressive. Their adoption is following a typical pattern where educators revert to old pedagogies as they come to terms with the capabilities of new technologies. (Herrington & Herrington, 2007)

Thus we find that students and teachers generally adopt new technologies by firstly reproducing activities that they already achieve using technologies thay are comfortable with. For example Powerpoint presentations are imported to an iPad or iPhone. However, by creating a mobile social media framework for creative pedagogies we can design and integrate the types of activities and pedagogies that support creativity and move beyond substitution towards redefinition, and move from teacher-directed pedagogy towards student-directed heutagogy. The research question informing the development of a mobile social media framework is therefore: How can mobile social media be used as a catalyst to enable new pedagogies that focus upon student-directed collaboration in and beyond the classroom?

Through implementing a series of over 45 mobile learning action research projects since 2006, we have developed a mobile social media framework to enable creative pedagogies in a variety of educational contexts (Cochrane, 2012; Cochrane & Bateman, 2013). Our mobile social media framework is essentially a mashup of concepts that we have found particularly useful to support the introduction of creative pedagogies via mobile social media. These include: the concept of the Pedaogogy-Andragogy-Heutagogy (PAH) continuum (Luckin et al., 2010), and Puentedura's (2006) SAMR model (Substitution, Augmentation, Modification, Redefinition) of educational technology transformation. Both of these pedagogical frameworks resonate with Sternberg, Kaufman and Pretz (2002) view of creativity involving incrementation (or modification of a current idea) followed by reinitiation (or redefinition). Using this framework we have designed and integrated the types of activities and pedagogies that support creativity and move beyond substitution towards redefinition, and move from teacher-directed pedagogy towards student-directed heutagogy. The implementation of the framework (Table 1) is supported by establishing communities of practice (COP) of department lecturers partnered with educational technologists, and creating a wireless screen-mirroring infrastructure to enable mobile devices to become collaborative tools nicknamed MObile Airplay Screens or MOAs (Cochrane, Munn & Antonczak, 2013) see http://bit.ly/1kN9Ah9.

Table 1. Creative pedagogies, technology and the PAH continuum (modified from Luckin et al., 2010)

	Pedagogy	Andragogy	Heutagogy
Activity Types	• Content delivery • Digital assessment • Teacher delivered content • Teacher defined projects	• Teacher as guide • Digital identity • Student-generated content • Student negotiated teams	• Teacher co-learner • Digital presence • Student-generated contexts • Student negotiated projects
Locus of control	Teacher	Student	Student
Cognition	Cognitive	Meta-cognitive	Epistemic
SAMR	Substitution & Augmentation • Portfolio to eportfolio • PowerPoint on iPad • Focus on productivity • Mobile device as personal digital assistant and consumption tool	Modification • Reflection as VODCast • Prezi on iPad • New forms of collaboration • Mobile device as content creation and curation tool	Redefinition • In situ reflections • Presentations as dialogue with source material • Community building • Mobile device as collaborative tool
Creativity (Kaufman & Pretz, 2012)	Reproduction	Incrementation	Reinitiation
Knowledge production	Subject understanding	Process negotiation	Context shaping
Self perception	Learning about	Learning to become	Active participation within the professional design community

3. EXAMPLES

The collaborative design of learning activities and assessments using mobile social media is illustrated in three different higher education contexts as briefly described in the following section. Each case study involved the formation of a COP of lecturers in a department and the researcher. The researcher modelled the use of mobile social media and brainstormed the integration into the curriculum of mobile social media with the course lecturers, who met weekly over a semester to explore the potential of new pedagogies enabled by mobile social media. The types of mobile social media activities that we introduced within each course were designed to move both pedagogy and student creativity along a continuum and are illustrated in Tables 2 to 4 summarising the use of our mobile social media framework.

3.1 Digital Media

The Digital Media project focused upon developing learning communities using Google Plus and the Google Plus App on smartphones and tablets. The researcher and the lecturers established a Google Plus Community to experience and explore the potential of mobile social media within the curriculum (http://bit.ly/GA4kQW). The main course assignment was the student team development of a m-learning application. The course assessment requirements were redesigned from focusing upon the submission of written Word report on the development process to the establishment of a team-based project eportfolio using mobile social media such as Google Plus Communities, Blogs and Google Drive. Students were able to use large screen displays or MOAs in class to collaborate on their App development and preview their development directly from their mobile devices, rather than create static screenshots and use PowerPoint presentations of the App as they had previously. Table 2 shows a comparison of an example of one previous assessment outline and the redesigned outline based upon our mobile social media framework.

Table 2. Assessment criteria for an educational mobile web app.

Previous assessment critieria	Redesigned assessment criteria
Your research on the topic you selected to be taught within a folder named "YOURINITIALS_Research"	Your research and media for the project must be uploaded to your Wordpress blog and external media embedded or linked to your blog.
A diagram of your mobile web app as a .pdf named "Diagram"	Make at least a weekly project progress summary blog post, and attach/embed supporting media to this post.
A Mockup of your mobile apps pages as .jpgs or .pdfs named "Wireframe"	Use the hashtag #148302a3 to filter blog posts and media for this assignment.
Your completed mobile web app and all its components contained in a folder named "WebApp"	Create a Google Plus Group for scheduling and recording your group meetings and activity.
Your individual contribution as a .doc names "INITIALS_Contribution"	Create a shared Mendeley library of your references, using APA formatting, and link this to a blog post named "References"
Your references as a .doc named "References"	Your final blog post will be a reflection on the project, including a summary of the team and your specific contribution to the team project - this can include a short 1 minute VODCast uploaded to either YouTube or Vimeo and embedded in your blog post.
Ensure all files are named correctly and contained within a folder labeled "TeamName_Brief4".	

Table 3 shows a comparison of the change in curriculum activities and assessments, with the original assessment approach situated firmly within a teacher-directed pedagogy, while the redesigned assessment activities move towards student-directed heutagogy.

Table 3. Mobile social media in the Communications curriculum

	Pedagogy	Andragogy	Heutagogy
Activity Types	• Teacher defined projects: course requirements, Project scope • Teacher delivered examples • Assignments descriptive • Assignment submission via Word reports and Powerpoint	• Teacher as guide • Digital identity: Wordpress journals • Student-generated content using smartphones • Student negotiated teams in Google Plus Communities	• Teacher modelling use of mobile social media within collaborative curriculum redesign team • Student-generated contexts: Authentic mobile App design and development
Creativity	Reproduction	Incrementation	Reinitiation

3.2 Graphics Design

This project centred upon the development of a lecturer community of practice to explore the development of a new media minor (http://bit.ly/1bRNyZR) consisting of four elective courses over three years of the degree within the school based upon mobile social media (Cochrane & Antonczak, 2013a; Cochrane & Antonczak, 2013b). The goal of this new minor is to transform students into creative professionals, by focusing upon ontological pedagogies (Danvers, 2003) that deal with the process of becoming, rather than pedagogies that focus upon knowledge transfer. Thus the new minor focuses upon extending students' experience and expertise beyond the formal requirements of the course to give them a real world collaborative experience via mobile social media such as Twitter, live streaming via Bambuser, eportfolios such as Behance.com, and the use of mobile devices to present in class reports and participate in live critique via screen mirroring of their mobile devices to MOAs. The development of the new media minor is structured around four new elective papers across three years, outlined in Table 4.

Table 4. Developing a new media minor based upon our mobile social media framework

Paper	Year	Credit & Level	Cognition level	Assessment activities	Conceptual shift	PAH alignment
Paper 1: Introduction to mobile social media	1	15 Level5	Cognitive	Personal digital identity building and student-generated content	Teacher modeled	Pedagogy
Paper 2: Mobile social media collaboration	2	15 Level6	Meta Cognitive	Collaborate in a team-based project as content creators	Teacher guided	Andragogy
Paper 3: Contextual affordances of mobile social media	2	15 Level6	Epistemic	Establishment of an international team project	Student negotiated	Andragogy to heutagogy
Paper 4: International community of practice	3	15 Level7	Epistemic	Active participation within a global professional community	Student directed	Heutagogy

The final paper of the new media minor features students creating and actively participating in a global team project, giving them an authentic experience of working in a professional community of practice within their discipline. The descriptor of this final course within the minor positions itself firmly within a heutagogical paradigm:

> Research, analytical, critical and creative capabilities are developed and refined in this student-generated project. Critical frameworks, collaborations, teamwork, intercultural competencies are explored to situate the students chosen area of research in relevant theoretical and professional contexts. Issues of mobile social media are examined within an international community of practice. Presentation skills are developed to position the research outputs in the setting of a body of work and project timeline and critical dates are negotiated between students and lecturers.

Table 5 shows a comparison of the change in curriculum activities and assessments in the new minor compared to other current papers in the Department.

Table 5. Mobile social media in the Graphics Design curriculum

	Pedagogy	Andragogy	Heutagogy
Activity Types	• Teacher defined projects: course requirements, Project scope • Teacher delivered examples • Assignments submitted via institutional Learning Management System (LMS)	• Teacher as guide • Digital identity: Behance eportfolios • Student-generated content: mobile film production • Student negotiated teams in collaborative projects	• Teacher modelling use of mobile social media within collaborative curriculum redesign team • Student-generated contexts: live streaming of events • Active participation in global teams
Creativity	Reproduction	Incrementation	Reinitiation

3.3 Journalism

This project involved the collaborative redesign of a New Media Journalism paper from a previous focus upon teaching students rudimentary web 1.0 development skills and the Powerpoint presentation of social media case studies from the lecturers, to providing students with an authentic experience of using and critiquing mobile social media as it has transformed contemporary journalism practice (Cochrane, Mulrennan, Sissons, Pamatatau & Barnes, 2013). The original course descriptor was:

> Examines the digital technologies and the issues affecting journalists and online news media sites. Covers the writing, editing and site design skills relevant to online journalism, including digital photography and image editing. Involves newsgathering with the aim of publication on the course website. (Course descriptor, 2009)

The new course descriptor redesigned based upon our mobile social media framework is:

> Examines and critiques mobile digital technologies, production and curation of news and social media source material within online news media sites. Covers the mobile recording of news via mobile applications in text, image, audio and video, including crowd-sourcing, live streaming and social media enabled collaboration within extended communities of practice. Involves news gathering with the aim of publication on the course website. Establishes eportfolios which become the basis for a professional entry into contemporary journalism. (Course descriptor, 2013)

The redesigned level 7 course offers students authentic team-based projects in which they are included as active negotiators of the project outcomes (heutagogy). Students now build a professional mobile social media identity throughout the course, and enage with mobile social media both during their class time and beyond class. Thus graduates will be better prepared to become active members of collaborative mobile social media journalism teams, both nationally and internationally. In this context the professional use of mobile social media was actively modelled, including the use of Twitter streams during class, student presentations from their mobile devices (for example: http://youtu.be/a58l3L5O18E), guest lecturers via Skype and other mobile live streaming Apps, and interactive crowd-sourced mobile discussion forums.

Table 6. Comparison of original and redesigned assessment activities

Previous assessment critieria	Redesigned assessment criteria
Assessment 1: In-class group presentation (PowerPoint) on aspects of media convergence, new media journalism and web-based reporting (10 marks) and an individual essay of 1000 words (20 marks)	Assessment 1: Students create an extended journalism community of practice facilitated by mobile social media, and curate and publish coverage of a public news event. Student teams then present their stories in class using mobile social media (Prezi, Skype, Vidyocast etc…), while being live-streamed to Bambuser, e.g. http://youtu.be/a58l3L5O18E
Assessment 2: Use the institutions LMS discussion forum to create a web-journalism portfolio – accessible by the class only	Assessment 2: Develop a real world personal journalism digital identity profile using mobile social media (Twitter, YouTube, Wordpress, LinkedIn etc…)
Assessment 3: Learn Dreamweaver for personal web design and production of a news-oriented website	Assessment 3: Students collaboratively curate, critique, and publish a news portfolio enabled via mobile social media tools for publication on the School's website using Storify. This includes the use of Twitter, blogs, live-blogging, Vidyocast videoconferencing, crowdsourcing, Vine and Vyclone. These pieces of content will be curated into a Storify with a total of 500 words giving context and analysis on the social media tool you have used, and how it has enabled the production of the item.

Twitter was used in the redesigned course to facilitate the building of an authentic professional journalism community. An interactive visual map of the Twitter interactions for the class hashtag over one week of the course was created using TAGSExplorer at http://bit.ly/18nl08G. The interactive visualization provides a quick overview of Twitter conversations via replies (solid grey lines), retweets (dotted blue lines) and mentions (dotted grey lines). The size of users nodes indicates their relative frequency and can indicate the most influential members and the style of communication, for example a single dominant node would indicate a broadcast mode. Individual nodes with no links indicate sharing of information but not within a conversation. In figure 1 we see that the lecturer is the dominant node that is modelling the use of Twitter to create conversation and engage with the community of students in the course. There are several strong student nodes indicating that the class is indeed developing a community of Twitter users around the course hashtag. The visual map also indicates the serendipitous involvement of twitter users beyond the class and users from the news professional community, thus giving the students an introduction to authentic participation within the professional journalism community. Table 7 shows a comparison of the change in curriculum activities and assessments between the original course outline and the redesigned outline based upon our mobile social media framework.

Table 7. Mobile social media in the Journalism curriculum

	Pedagogy	Andragogy	Heutagogy
Activity Types	• Teacher defined projects: course requirements, Project scope • Teacher delivered case studies • Mobile social media activity during class seen as purely social	• Teacher as guide • Student curation of social media via Storify • Student-generated content via Twitter • Student negotiated teams	• Teacher modelling use of mobile social media within collaborative curriculum redesign team • Students actively participate within an authentic professional community
Creativity	Reproduction	Incrementation	Reinitiation

3.4 Summary

In each of these examples we have seen a significant change in pedagogical strategies and the integration of mobile social media in ways that move beyond merely substituting prior activities onto new technologies. By focusing upon a goal of transforming education from teacher-delivered content to enabling authentic collaborative experiences for our students we have leveraged the unique affordances of mobile social media to achieve this within different educational contexts. Critical to this has been the establishment of collaborative communities of practice of lecturers and educational researchers who have modeled the use of mobile social media in their own teaching practice. Reconceptualising the role of the teacher and the learner has enabled a focus upon ontological pedagogies rather than the previous default teacher-directed pedagogies. Future research will explore the transfer of this framework within other higher education institutions throughout New Zealand, and potentially internationally by establishing international COPs.

4. CONCLUSION

In this brief overview we have outlined how mobile social media can be used as a catalyst for creative pedagogies when informed by the concepts of new pedagogical frameworks such as the pedagogy-andragogy-heutagogy continuum, and Puentedura's SAMR framework. We have described the application of a mobile social media framework to three different course contexts illustrating the potential for this framework to be used or transferable in a range of educational contexts and fields to encourage creative pedagogies.

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FACTORS AFFECTING M-LEARNERS'COURSE SATISFACTION AND LEARNING PERSISTENCE

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ABSTRACT

This study investigated whether college students' self-efficacy, level of learning strategy use, academic burnout, and school support predict course satisfaction and learning persistence. To this end, self-efficacy, level of learning strategy use, academic burnout, and school support were used as prediction variables, and course satisfaction and learning persistence were used as criterion variables. Subjects were 178 students registered for online and mobile "Culture and Art History" courses in the 2012 second quarter of K cyber university. They participated in an online survey. Multiple regression analysis revealed that self-efficacy and level of learning strategy use positively predicted course satisfaction and learning persistence, and academic burnout negatively predicted course satisfaction and learning persistence. However, school support did not predict either course satisfaction or learning persistence. Accordingly, we suggest that raising self-efficacy and level of learning strategy use, and reducing academic burnout in the learning environment will improve course satisfaction and learning persistence of cyber learners.

KEYWORDS

Self-efficacy, Level of Learning Strategy Use, Academic Burnout, School Support, Course Satisfaction, Learning Persistence

1. INTRODUCTION

The development of information and communication technology, which has overcome the limitations of time and space, has made education possible in a variety of environments. One representative internet-based educational institution is cyber university.

Cyber universities are able to provide educational opportunities to a variety of students such as office workers, people with disability, and school age and adult learners who were prevented from obtaining education. There are variety of students enrolled in cyber universities, such as adult learners who missed their chance to enter the university, as well as enrolled students with special circumstances, such as students from the industry and military bases, Koreans living overseas, and foreigners (Ministry of Education, Science and Technology, Korea Education and Research Information Service, 2011).

In addition, the use of smart phones and the number of domestic mobile unit holders has increased by more than 70% (Korea Information Society Development Institute, 2012). Thus, the cyber university in Korea is able to support mobile learning services that provide ubiquitous learning environments for 16 cyber universities out of 20 universities (Ministry of Knowledge and Economy, 2012).

However, since the launch of cyber universities in 2001, while there is a continuing increase in its number, dropouts are more frequent compared with off-line universities (Lim, 2007). These problems raise doubts about the performance of cyber universities. Furthermore, some have suggested problems with the quality of education at cyber universities (Kwon, 2009; Jeon, 2010). Thus, research to improve learning outcomes, such as course satisfaction and learning persistence, in cyber learning environments may contribute to the quality of cyber universities (Maki & Maki, 2003; Martinez, 2003).

Because most cyber university administration, teaching, and learning are conducted online, learners' active participation is very important for successful learning outcomes. Therefore, self-efficacy in cyber-learning environments and the degree to which learners' use learning strategies for more effective learning are important variables (Bandura, 1977; Park & Choi, 2008). Unlike traditional college students, cyber learners more frequently drop out due to internal as well as external stress factors (Kwon, 2009; Jeon, 2010). In particular, given that 69% of cyber university students have jobs (Ministry of Education, Science, and Technology, 2011), it is important to investigate whether academic stress and psychological variables such as mental load undermine their learning persistence (Jeon, Kim, 2012b; Joo, Jung, & Lim, 2012).

Previous research studies have reported that academic burnout reduces learning achievement and school life-satisfaction (Jeon & Kim, 2012a). Current research aims to provide basic research on the sustainability of cyber universities by additionally investigating positive and negative variables related to course satisfaction and learning persistence.

The aim of this study was to investigate whether intrinsic motivation variables such as self-efficacy, level of learning strategy use, and academic burnout predict course satisfaction and learning persistence, and school support, which has been shown to affect learning outcomes in traditional learning environments (Joo, Kim, & Kim, 2010), was added as an external environmental variable.

Specific research questions based on the hypothetical research model in Figure are as follows:

Research Question 1: Do cyber university students' self-efficacy, level of learning strategy use, academic burnout, and school support predict level of satisfaction?

Research Question 2: Do cyber university students' self-efficacy, level of learning strategy use, academic burnout, and school support predict learning persistence?

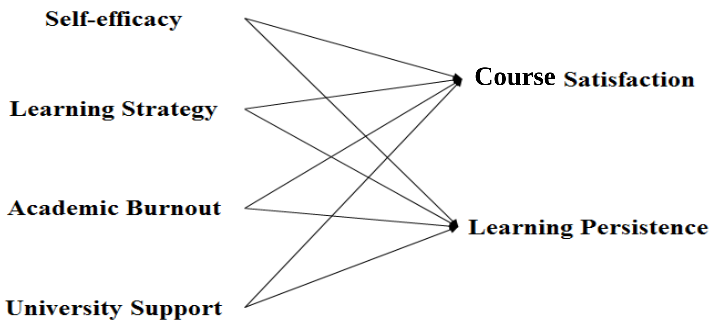

Figure 1. Hypothetical Research Model

2. RESEARCH METHOD

2.1 Subjects and Procedure

The current study targeted 228 students taking "Culture and Art History" from the department of Culture and Arts Administration at K Cyber University to investigate whether cyber university students' self-efficacy, use of learning strategies, academic burnout, and school support predict course satisfaction and learning persistence. K Cyber University students in computer-based online courses were able to attend online video lectures through a mobile application. Learners are able to attend video lectures through mobile applications that included a variety of functions such as announcement confirmation, score inquiry, and social networking services. The survey was administered two weeks prior to the end of the semester. To increase the response rate, the system encouraged students to participate in the survey through announcements and e-mails. One hundred and seventy-eight surveys were included in the final dataset, with the exception of two incomplete responses. Among the 178 subjects, 37 (20.8%) were male and 141 (79.2%) were female, and age ranged from 20–50 years. In terms of student occupation, 122 (68.5%) subjects were full-time employees, 14 (7.9%) were contractual employees, and 42 (23.6%) were unemployed. Among the 136 employed subjects, 49 (36.0%) were professional workers, 41 (30.1%) were office workers, 36 (26.5%) were service workers, and 10 (7.4%) were managerial workers.

2.2 Measurement Instrument

2.2.1 Self-efficacy

Self-efficacy was measured using nine modified items about self-efficacy from the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich and De Groot, 1990). These items were answered using a 5-point Likert scale. A sample item is “I expect that I will be able to learn very well in this course.” The Cronbach’s α of the original instrument was .89, and was .95 in the current study.

2.2.2 Level of Learning Strategy Use

The level of learning strategy use was measured using 14 questions about self-assessment, organization and transition, goal setting and planning, information search, record-keeping and coordination, configuration, self-reward, demonstration and remembering, asking for help (peers, teachers, and adults), and data review (paper, notes , materials) from Zimmerman and Martinez-Pons (1986). These questions were modified for cyber university learning environments.

A sample questions is “I ask for help from peer learners when I encounter a difficult study situation.” To examine its validity, we conducted a factor analysis with the 14 items, and a single factor emerged.

Single factor loading values were above ± .4, which supports the validity of the extracted factors (Seong, 2007). The Cronbach’s α was .87 in the original instrument by Zimmerman and Martinez-Pons (1986), and .92 in the current study.

2.2.3 Academic Burn-Out

The level of learning strategy use was measured using 14 questions about self-assessment, organization and transition, goal setting and planning, information search, record-keeping and coordination, configuration, self-reward, demonstration and remembering, asking for help (peers, teachers, and adults), and data review (paper, notes , materials) from Zimmerman and Martinez-Pons (1986). These questions were modified for cyber university learning environments.

A sample questions is “I ask for help from peer learners when I encounter a difficult study situation.” To examine its validity, we conducted a factor analysis with the 14 items, and a single factor emerged.

Single factor loading values were above ± .4, which supports the validity of the extracted factors (Seong, 2007). The Cronbach’s α was .87 in the original instrument by Zimmerman and Martinez-Pons (1986), and .92 in the current study.

2.2.4 School Support

School support for cyber university students was measured as in Joo & Young-Ju (2010). There were six questions, such as “school or faculty (operator) explained that education is necessary.” Cronbach's α was .89 in the study by Joo & Young-Ju (2010), and .92 in this study.

2.2.5 Course Satisfaction and Learning Persistence

We revised the instrument by Shin (2003) to measure course satisfaction and learning persistence. Course satisfaction was measured with eight items, including general satisfaction level, achievement, satisfaction with attending lecture, and intention of recommending others. A sample question is “It was a valuable experience for me to study this course.” Cronbach’s α was .94 in the study by Shin (2003), and .96 in the present study.

Learning persistence was measured with six items, including the importance of completing course, and willingness to overcome the impediments to learning persistence. A sample questions is “I will enroll in the next semester.” Cronbach’s α was .83 for the original tool, and .90 in this study.

2.3 Data Analysis

We analyzed the data obtained through online surveys to find the general nature of each variable. We calculated the mean and standard deviation for self-efficacy, level of learning strategy use, academic burnout, school support, and course satisfaction. We also calculated Pearson’s correlation coefficients to analyze the relationships between variables.

To analyze the internal consistency, Cronbach's α coefficients were calculated. A violation of the multicollinearity assumption was found for self-efficacy, level of learning strategy use, academic burnout, and school support. Finally, we performed a multiple regression analysis to determine whether self-efficacy, level of learning strategy use, academic burnout, and school support predict course satisfaction and learning persistency. We considered the unique contribution of each independent variable by inserting the independent variables simultaneously (Seong, 2007).

3. RESULTS

3.1 Descriptive Analysis

We calculated the mean, standard deviation, minimum and maximum value, skewness, and kurtosis of self-efficacy, level of learning strategy use, academic burnout, school support, course satisfaction, and learning persistence. The descriptive statistics for each variable are displayed in Table 1.

Table 1. Descriptive statistics of self-efficacy, level of learning strategy use, academic burnout, school support, course satisfaction, and learning persistence (n = 178)

Variables	Mean	*SD*	Skewness	Kurtosis	Min.	Max.
Self-efficacy	3.46	.68	-.13	-.15	2.00	5.00
Level of learning strategy use	3.49	.69	.02	-.47	2.00	5.00
Academic burnout	2.18	.83	.73	.40	1.00	5.00
School support	3.03	.88	-.26	-.28	1.00	5.00
Course satisfaction	4.01	.79	-.53	-.46	2.00	5.00
Learning persistence	4.23	.88	-1.17	.53	1.00	5.00

As shown in Table 2, there was significant correlation among all measured variables. We verified whether there was a Variance Inflation Factor (VIF) because the correlations between variables were high. Because there was no measured variables with VIF are greater than 10, we concluded that there was no multi-collinearity

3.2 Correlation Analysis and Verification Multi-Collinearity

We conducted a multiple regression analysis to examine if cyber students' self-efficacy, level of learning strategy use, academic burnout, and school support predict course satisfaction. Self-efficacy, learning strategy use, academic burnout, and school support were predicting variables, and course satisfaction was the criterion variable (see Table 3).

Table 2. Correlations among Self-efficacy, level of learning strategy use, academic burnout, school support, course satisfaction, and learning persistence

Variables	1	2	3	4	5	6
1. Self-efficacy	-					
2. Level of learning strategy use	.770*	-				
3. Academic burnout	-.719*	-.660*	-			
4. University support	.484*	.555*	-.279*	-		
5. Course Satisfaction	.732*	.750*	-.727*	.455*	-	
6.Learning persistence	.676*	.655*	-.730*	.322*	.808*	-

*p < .05

As shown in Table 3, level of learning strategy use, academic burnout, and self-efficacy resulted in two statistically significant regression models. Approximately 67.7% of the variation in satisfaction was accounted for by self-efficacy, learning strategies, level of learning strategy use, academic burnout, and school support. Academic burnout (β = - .357), level of learning strategy use (β = .328), and self-efficacy (β =. 182) significantly predicted course satisfaction. School support did not predict satisfaction.

3.3 Self-Efficacy, Level of Learning Strategy Use, Academic Burnout, School Support, and Course Satisfaction

We conducted a multiple regression analysis to determine whether cyber students' self-efficacy, level of learning strategy use, academic burnout, and school support predict learning persistence. Self-efficacy, level of learning strategy use, academic burnout, school support, and commitment were predictor variables, and learning persistence was the criterion variable.

Table 3. Self-efficacy, learning strategies, utilization levels, academic burnout, school support predictions of the course satisfaction

(n = 178)

Dependent Variable	Independent variables	***B***	*SE*	*β*	t	*p*
Course Satisfaction	Constant	2.478	.386		6.415	.000
	Self-efficacy	.211	.089	.182	2.364*	.019
	Level of learning strategy use	.377	.086	.328	4.371*	.000
	Academic burnout	-.342	.063	-.357	-5.445*	.000
	University support	.077	.048	.086	1.601	.111
R^2($adj.$ R^2) = .677(.669), F = 90.617, p = .000						

*$p < .05$ ( )Adjusted R^2

As shown in Table 3, level of learning strategy use, academic burnout, and self-efficacy resulted in two statistically significant regression models. Approximately 67.7% of the variation in satisfaction was accounted for by self-efficacy, learning strategies, level of learning strategy use, academic burnout, and school support. Academic burnout (β = - .357), level of learning strategy use (β = .328), and self-efficacy (β =. 182) significantly predicted course satisfaction. School support did not predict satisfaction.

3.4. Self-Efficacy, Level of Learning Strategy Use, Academic Burnout, School Support, and Learning Persistence

We conducted a multiple regression analysis to determine whether cyber university students' self-efficacy, level of learning strategy use, academic burnout, and school support predict learning persistence. Self-efficacy, level of learning strategy use, academic burnout, school support, and commitment were predictor variables, and learning persistence was the criterion variable.

Table 4. Self-efficacy, learning strategies, utilization levels, academic burnout, willing to continue the school's academic support predictions

Dependent Variable	Independent variables	*B*	*SE*	*β*	t	p
Learning persistence	Constant	3.513	.480		7.325	.000
	Self-efficacy	.242	.111	.188	2.191*	.030
	Learning strategy	.282	.107	.221	2.638*	.000
	Academic burnout	-.485	.078	-.455	-6.222*	.000
	University support	.018	.060	-.018	-.303	.763
$R^2(adj.\ R^2) = .598(.588)$, $F = 64.283$, $p = .000$						

$^*p < .05$

As shown in Table 4, the regression model with level of learning strategy use, academic burnout, and self-efficacy as inputs was statistically significant. Self-efficacy, level of learning strategy use, academic burnout, and school support accounted for 59.8% of the variance in learning persistence. Self-efficacy (β = .188), level of learning strategy use (β = .221), and academic burnout (β = -.455) were significant predictors of learning persistence.

Meanwhile, school support did not predict learning persistence. The relationship based on the analysis of the standardized β coefficient, which expresses the standardized relationship among each variable, is illustrated in Figure 2.

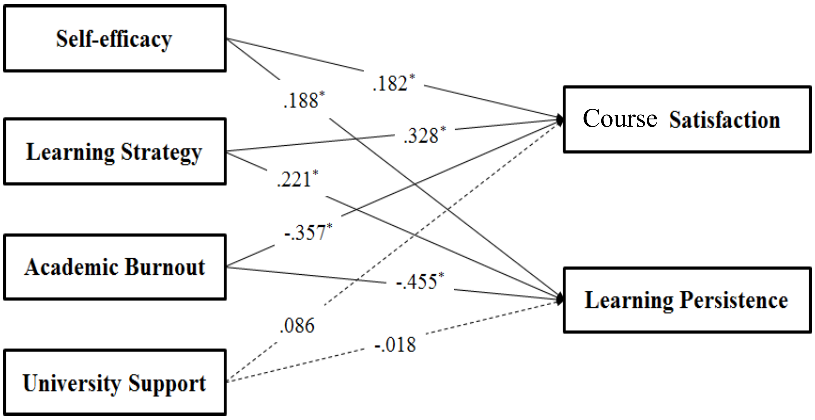

Figure 2. Self-efficacy, level of learning strategy use, academic burnout, school support, course satisfaction, and learning persistency

4. CONCLUSION

The research results are as follows: first, cyber university students' self-efficacy, level of learning strategy use affected course satisfaction in a positively significant way but the academic burn-out affected course satisfaction negatively significant, did, and school support predicted the level of course satisfaction. Second, cyber university students'self-efficacy, level of learning strategy use affected course satisfaction significantly in a positive direction but the academic burn-out affected course satisfaction in a negatively significant way. The effect of school support on learning persistence, however, was not significant.

Self-efficacy significantly predicted course satisfaction. The results are consistent with previous study results dealt with a variety settings (Park, Joo, Bong, 2007, Ryu, 2003; Joo, Kim, Kimm 2008; Artino, 2008; Liaw, 2008). However, school support did not significantly predict the course satisfaction, which was not consistent with previous studies(Paechter, Maier and Macher, 2010). The significant effects of self-efficacy, level of learning strategy use, academic burn-out on learning persistence were consistent with previous study results(Jeon, Kim, 2012; Joo, Hong, & Lee, 2011). In particular, the current research results that academic burn-out is negatively effective on course satisfaction and learning persistence is very meaningful since it investigated the negative factor, which negatively affect learning outcomes in cyber and m-learning.

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A FRAMEWORK TO SUPPORT MOBILE LEARNING IN MULTILINGUAL ENVIRONMENTS

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ABSTRACT

This paper presents a multilingual mobile learning framework that can be used to support the pedagogical development of mobile learning systems which can support learning in under-resourced multilingual schools. The framework has been developed following two empirical mobile learning studies. Both studies were conducted in multilingual South African high schools where learners were provided with mobile phones to access a multilingual system called M-Thuto. In the first study, 90 learners interacted with a bilingual application that included class notes, drill exercises and a quiz for their mathematics lessons. In the second study, 32 learners were expected to create audio clips of their notes gathered from their daily physical science lessons using their home languages. The learners uploaded these notes onto an online mobile learning system and used them later for revision. Data were gathered from their interactions in both studies through interviews and questionnaires and analysed through descriptive statistics and a thematic analysis. These results have contributed to a framework which prescribes factors that need to be considered when creating multilingual mobile learning systems that support the process of learning in developing country secondary schooling environments.

KEYWORDS

Mobile learning, Framework, Multilingual, Secondary schools, South Africa.

1. INTRODUCTION

Learning in both formal and informal environments has conventionally been supported by traditional learning theories and sources such as physical textbooks to enable the process of learning. The introduction of mobile learning in traditional environments has not only brought new platforms of receiving education but has also affected the way in which children learn. While there has been widespread implementation of mobile learning initiatives throughout the world (UNESCO, 2012), there is currently a need for mobile learning frameworks which support the development of mobile learning systems in secondary school education, reflecting how mobile learning can be effectively used to support learning in multilingual environments while reducing the learning resource challenges that learners face. In this paper we consider the introduction of mobile learning in under-resourced traditional high school learning environments. We propose on how mobile software can be designed to support multiple language users as a way of extending learning resources to communities that would have previously not had the opportunity of accessing learning technologies. Based on empirical work, we propose a framework which presents the pedagogy development considerations when creating a mobile learning tool to be used in similar contexts. Learning environments, especially in primary and high schools, are often challenged by the lack of wireless connections in classrooms, in learners' home environments, and by the lack of access to mobile learning software that supports a multilingual mobile learning environment (Traxler, 2007). The pervasive use of mobile devices across the world, while introducing the prospects of learning on mobiles, also introduces a need for context aware learning resources. Context awareness in this paper not only refers to formal and informal contexts, but it also refers to the geographic issues, such as diverse languages and the process of learning through these languages, which are indigenous to that learning environment. While mobile learning support advances beyond the basic use of mobile device features, such as schedules, memos, text and calls, there is a greater need for systems which not only provide pedagogy support but also consider the contextual challenges of a learning environment (Chuang, 2009).

2. LITERATURE BACKGROUND

2.1 Mobile Learning Frameworks

From the inception of mobile learning, a variety of mobile learning frameworks have contributed towards its development. This section gives a brief overview of various mobile learning frameworks with each framework providing a different focal perspective on the mobile learning environment.

Sharples *et al*. (2005) present a framework which illustrates the outcomes of allowing the teachers and learners to have control over the mobile device and the mobile learning process as essential elements. The framework proposes the support of context by synchronising elements of the context to support learning in the mobile learning process. Peng *et al.* (2009) present a framework which considers mobile learning as a platform to cultivate lifelong learning. The framework emphasises the importance of supporting the mobile learning facilitator as they often may not have the skills to facilitate a mobile learning process. The authors also highlight the importance of facilitator contribution in defining the mobile learning process objectives. Chen *et al*. (2008) presents a web-based mobile learning framework which outlines the intergradation between the technology and the learner's interaction as essential components of a mobile learning process. Each learner in the framework has a profile providing a personalised interaction in a learning environment. The framework suggests context awareness and adaptation to context as important elements of a mobile learning environment. While the above frameworks further the development of mobile learning in improving its adaptation and adoption, the suggested elements mainly do not address the language and high school constraints that come with supporting diverse schooling communities. There is a need for further research into globalising and diversifying frameworks to support any linguistic learning environment.

2.2 Context Awareness through Linguistic Inclusion

Pressure to protect native languages in online technology has been seen through the development of policies that require local content to be developed in local languages, such as in France and Brazil. Symbolising the move towards global inclusion of multiple languages in technology, the Chinese language has gained ground as a growing online language which does not follow a Roman letter standard (Gandal and Shapiro, 2001). African countries such as Kenya (Candelaria-Greene, 1996) and South Africa (Banda, 2000) have excellent educational frameworks to support bilingual education. However, most African countries are still lagging behind the rest of the world in terms of being able to use indigenous languages to deliver online and offline learning.

Bilingual learning in multilingual environments

In bilingual or multilingual environments, bilingual speakers use two or more acquired languages when communicating. Their lack of consistency in using one language at all times gives them the comfort to alternate words of both languages. The terminology used to describe this phenomenon is *code-switching*, which is the use of two languages to communicate in an instance or conversation, and is common in bilingual classrooms (Setati, 2008). In multilingual countries where the language of learning differs from the teacher's and learner's home language, the same process of switching is also experienced in the learning environment. Learners will switch between the language of teaching and learning and their home languages. This helps them to better understand what they are taught by interpreting the content in more than one language. Teachers in these situations also switch to support their learners to gain a greater understanding of content, especially where learners fail to appropriately interpret the learning content. Then and Ting (2011) conducted a study on the reasons for code-switching from the teacher's perspective. The study was performed in Malaysian schools in which the learners and teachers were bilingual, and teachers expressed the challenges they came across when teaching bilingual learners. In many instances, learners failed to understand and easily grasp requirements as a result of lack of academic language proficiency. Learners end up producing unrelated answers to tasks, and teachers are therefore forced to code-switch, to ensure that learners understand what is required from them. This problem was not only experienced in language classes but also across other subjects and necessitates learning technology which is designed to support this process.

3. EMPIRICAL RESEARCH

3.1 Previous Findings

Two previous studies were conducted (Jantjies and Joy, 2012; Jantjies and Joy, 2013) which sought to determine factors that need to be considered when supporting multilingual learning environments through mobile learning. The findings of these studies have been used to develop the framework presented in this paper. Scenarios have been used here to illustrate the challenges of a multilingual learner which the framework aims to improve.

Formal learning scenario: South Africa has eleven official languages with only one language of instruction, while making provision through law for other South African languages to support the learning process. Lesego is a high school learner in South Africa. Her first language and her fellow classmates' first language is Setswana, but the medium of education in their school is English. In Lesego's mathematics classroom the teacher, Mrs Kgosigadi conducts the daily lessons in English while making reference to some terms in Setswana. The teacher also sometimes stops to explain mathematical concepts using both Setswana and English (code-switching). An example of such a conversation between the teacher and her learners is, "When you add 3 and 4 ***o tla bona karabo e e latelang*** which is 7". This is translated to "When you add 3 and 4 you will see the following answer which is 7". Sometimes the teacher also introduces a topic in English and later explains the same topic in Setswana. While the teacher is teaching, Lesego raises her hand to ask a question, switching between English and Setswana. When the teacher realises that Lesego did not understand, Mrs Kgosigadi explains the concept in English and then again extensively in Setswana so that Lesego and the rest of the class can understand. There are mathematics text books and online resources published in the learners' second language which is the language of learning and teaching. However, Lesego's school struggles with providing sufficient infrastructure, and there is a lack of computers, Internet connections and an insufficient number of text books per learner. Learners also struggle with access to multilingual learning content to support their switch between languages in order to fully grasp the learning content. These learners have to seek other means of getting sufficient learning support materials to ensure that they learn well. Most of Lesego's classmates cannot afford alternative and online learning resources. Even though the South African government supports bilingual learning, there are limited learning resources that support learning through indigenous languages such as Setswana. The advantages of this class and many other developing communities is that each learner has access to a mobile phone which is WAP enabled, allowing cheaper access to online and offline resources which can support a mobile learning environment.

Informal learning scenario: Bhekisizwe is at home reading the notes that he copied during class from the board written in English. Bhekisizwe stumbles across a fact he does not understand. Bhekisizwe tries to reinterpret this concept in Setswana, translating word for word what the concept means. In their home environment Bhekisizwe and other learners depend on the notes they received in class and also on their text books to access learning material. Tasks that require learners to learn beyond the classrooms are often difficult to execute as learners would fall short of sufficient learning material beyond the classroom. In terms of language support, tasks that require further information to be used to informal learning requires consistent support for code-switching as the teacher is not present to re-present the concept again in Setswana, having material which is context friendly enables ubiquitous and language supportive learning in informal spaces. Providing learners with a comprehensive learning tool which gives learners a central access point of learning material beyond the classrooms enables ubiquitous learning to occur seamlessly.

3.2 Research Methodology

In the authors' previous work (Jantjies and Joy, 2012; Jantjies and Joy, 2013) two multilingual mobile learning studies were conducted to address the following question:

> *How can mobile learning be used to support the process of learning in multilingual formal and informal environments?*

Each system was developed with teachers' help. After obtaining the teaching and learning objectives from the teacher, the system content was created to answer three main questions: *what* (was to be learnt), *why* (was it to be learnt) and *how* (was it to be learnt) (Ally, 2004). In study 1 (Jantjies and Joy, 2012), 90 learners from a high school in South Africa were provided with mobile phones that were WAP enabled and access to an online mathematics bilingual learning application called M-Thuto. The application provided them with a view of their mobile learning content in two languages allowing them to navigate between their home language and the language of instruction while learning mathematics. The content of the application was created to support them to learn simultaneous equations by providing class notes, drill exercises and a quiz on the topic. The system supported their formal learning process through allowing learners to understand and reflect on learning content with the option of using a language view of their choice during the study. In study 2 (Jantjies and Joy, 2013), 32 learners from a South African physical science high school class were provided with an opportunity to create multilingual audio clips of their learning notes gathered from their daily science lessons and other technology resources. After creating these notes, learners uploaded the notes onto an online mobile system under their profiles. This activity enabled learners to explore and reflect on the learning topic using the languages they could best comprehend the learning content through. Both of the above mentioned studies were conducted in a multilingual learning context. After interacting with the systems above, learners from both studies provided feedback through interviews and questionnaires. The data were analysed using thematic analysis and descriptive statistics. Study 1 was based in a formal learning environment while study 2 was based in an informal learning environment.

3.3 Summary of the Results

Learning technology

In study 1 only 22% of the learners had access to computers. In study 2, however, the school had computers in the school grounds, but these computers were only used by learners registered for the computer studies subject. Even though learners were at times expected to use the intervention of a computer to do their homework, most of them could not afford to go to a local Internet cafe to use their computers. However most of the participating learners in both studies either owned a mobile phone or had access to a mobile phone.

Language support

In study 1 the learners were enthusiastic about the ability to navigate between two languages in learning software. Of the participating learners, 61% in study 1 effectively navigated between the two languages that the learning content was available in to access the same content. The remaining learners stayed on one language page to read the learning content. A suggestion was made by one of the learners that the application could also have an option to allow looking up a word explanation in one view without necessarily having to navigate to the other page to view the same content in another language. This would enable learners to check a particular word instead of viewing the whole content in another language. In study 2 learners were required to create their own notes in their languages. In this study 80% of learners switched between English and other languages to create the clips. Even though the learners were in an informal environment, their linguistic conduct was formal as they knew that they were creating audio clips which were used for learning. The learners switched between two or more languages, which their teacher understood, to create the clips. The learners found the process to be effective as they felt they could fully explain and comprehend what they were recording. This process also gave their teacher an opportunity to monitor the learners understanding as the system gave her access to the audio clips.

The learning context and learning activities

In study 1, 83% of the learners cited that the mobile learning process enabled them to work without the teacher being present. This encouraged ubiquitous learning in both formal and informal settings. In this study two of the four teachers participated in the mobile learning process which also presented the possibility of teachers being able to effectively use mobile learning within classrooms to support the learning process. Learners practiced simultaneous equation exercises from their mobile phones and also asked their teachers for assistance. In study 2 the learners worked in informal learning environments. The learner's perspectives on the frequency of revising their work changed with the study. Learners felt that they were motivated to create their audio learning notes as the mobile learning process moved away from their traditional method of learning and gave them an alternative option, with an increased number of learners creating audio notes on a weekly basis. In this study just 20% of the learners used only the instruction language to create their audio notes while the rest code-switched between their home languages and the language of instruction. The learners highlighted that they could best engage with these notes as they were the authors, which enhanced their learning process.

3.4 A Multilingual Mobile Learning Framework

In this paper, we propose a framework that can support the development of mobile learning systems in multilingual high school learning environments, considering how multilingual learning content and activities traditionally occur in different learning context.

3.4.1 Considering the Mobile Learning Role Players

In this section we present different role players in a mobile learning environment which enable the mobile learning processes to occur.

The mobile learner – The mobile learner in under-resourced environments is a learner who is limited by the types of devices which they have access to. Understanding the mobile learner in this case enables the developer to know that, even though the learner can have access to a ubiquitous platform such as a mobile phone, the learner may not have a WAP enabled mobile device or access to a wireless network to support the mobile learning process. Systems should thus be designed to support both on- and offline learning. In this framework we also consider the mobile learner as a multilingual learner who uses more than one language to interpret learning content. This learner requires equal support of both learning languages as they provide equal support in their learning process. The mobile learner also uses different methods to learn, which are based on traditional learning theories such as constructing knowledge, reflecting on knowledge and consistent practice of knowledge in order to remember the learning concepts. These theories should be considered in the development of learning content and activities as they support the manner in which pedagogy can be acquired.

The mobile learning teacher – The mobile learning teacher becomes the facilitator of the mobile learning process and the principal contributor towards the mobile learning content. The teacher is able to design learning content which can support bilingual learning as they also use bilingual teaching to support the learning process. Considering the challenges that this teacher faces with a lack of skill in ICT use in classrooms, technology designed for these teachers needs to involve their participation in the design process in order to enable them to understand the support role that the mobile device plays in the learning process. As we consider environments which will have a shortage of resources, mobile devices cannot be used extensively by teachers as they face limits, the mobile technology in the teacher's class thus plays more of a supportive role as an additional resource, instead of a tool which changes their daily practice.

The mobile phone as a mobile learning device – Mobile phones are used in different ways to support mobile learning. Due to the high rate of mobile phone use throughout the world, mobile phones are currently not only the most affordable but also the most pervasive technology in this learning context. Furthermore, mobile phones are not limited to a single context and can be effectively used through already embedded features such as image, video and audio recording, text sending and others, to support learning without having to rely on custom software to enable the mobile learning process. The development of a mobile learning system in this context needs to consider the limits of the mobile phones that will access the system providing support through design for both feature and non-feature phones.

The mobile learning context – The context of learning affects the manner in which learner's progress. The context in which the mobile learning software is deployed plays a key role in determining the how languages are used in both formal and informal learning. This also allows the developer to narrow down the prescribed languages to the context in which they are used. Similarly, mobile learning activities are also affected by the context in which they occur and should be modelled to suit the learning context. For example, formal learning environments would need activities which support the teacher as the main facilitator providing learning notes and class exercise, while in informal environments, learning needs to be more robust and engaging to overcome the challenges associated with informal environments.

The mobile learning content – Learning content in multilingual environments needs to be initially created to serve multilingual speakers. This does not imply a direct translation of content but implies an initial *design* of the same learning content in multiple languages. Similarly the content should also be modelled around the activities and context in which the learning occurs. For example, quiz challenges can be designed to help learners reflect on a topic and content which can be used to support informal learning, while formal content can be designed supporting the teaching in classrooms, for example by presenting the teacher's summarised notes for learners to refer to the learning content.

3.4.2 The System Architecture

The basic architecture of the system is based on previous studies of Jantjies and Joy (2012; 2013).

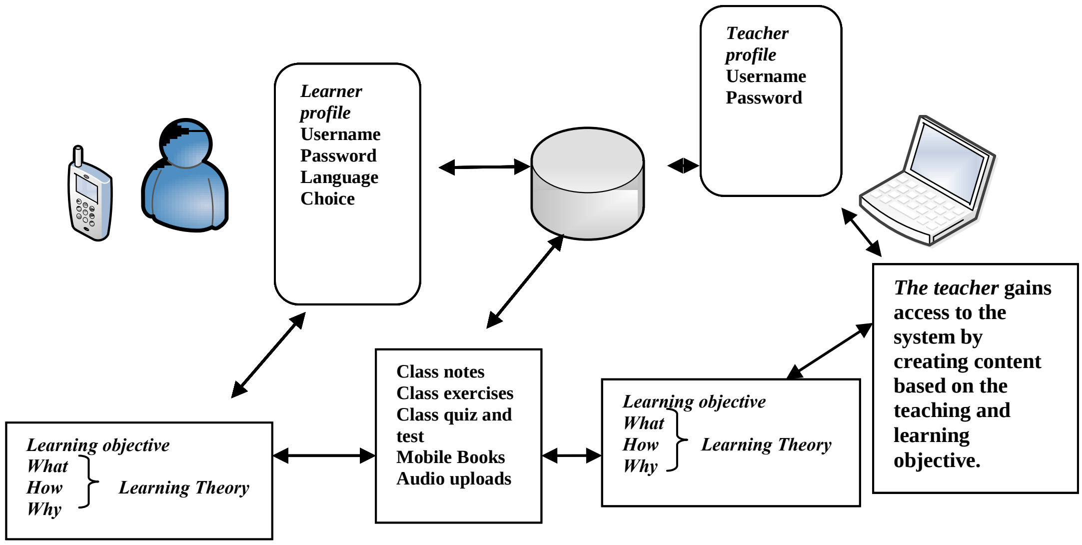


Figure 1. System Architecture

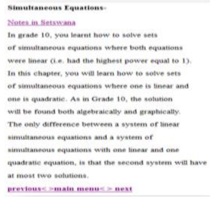
Figure 1 presents an architecture where the teacher accesses the system through their profile to prepare learning content based on teaching and learning objectives. In supporting the learning process, the learning objectives are based on what the learner can achieve through the learning process answering three main questions of what to learn, how to learn and why are they learning. The teacher is also able to access the performance of learners by tracking down their interaction with the system. Each learner also has a profile in which they access the system. The system provides the learners with learning content which is based on the learning objective. To reach their learning objective the system presents learners with different learning components which enable them to learn: class notes, class exercises, class quizzes and tests and finally summarised mobile books. The system also provides them with a portal to upload learning audio files similar to those in study 2 (Jantjies and Joy 2013).

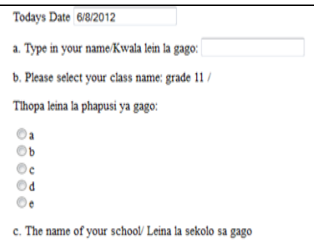
3.4.3 The Pedagogical Design

Supporting multilingual content and learning in formal environments

In multilingual formal learning, teachers use two or more languages to introduce learning content, to reaffirm the learning content or a concept, and rarely to translate content to learners. In this framework we proposed three methods based on classroom practice to support multilingual learning as the switch between languages occurs less frequently. In figure 2, when introducing new topics, content can be presented in small units, first in language A, and the same content originally developed in language B can be available for learners to choose whenever they want to switch to another language. This process can be supported through extensive navigation facilities that allow the learner to switch the page view from language A to B while remaining on the same topic. When reaffirming learning content, each line of content can be presented in a subtitle view with language A as the first line followed by the same content below in language B, forming an interchange of languages between the lines. The teacher or content developer can decide on how often (after every sentence or every second sentence) the switch will occur. The final method of supporting a bilingual learner through content development is by providing a direct translation service which enables each word to be translated from language A to language B. Through the approach of Van Huyssteen *et al.* (2007) a learner can select a word and view its alternatives in other languages. In supporting the process of formal learning, the system can provide class notes, class exercises with worked solutions, and class quizzes. As previously stated in the architecture, each system design process should be developed to answer the learning objective of *what* is to be learned, *how* it will be learned and *why* will it be learned. In each page view either one of the above mentioned techniques also reflected in figure 2, can be used to support multilingual learning.

Introducing content: Having the same content in two or more languages allowing a learner to select anytime during the learning process to switch to the language of choice.	***Reformulation***: Having each line of content available in the same view preceded by the same content in another language.	***Translation***: Allowing the learner to select a word anytime during the learning process to select an alternative of the word and view its equal in another language.





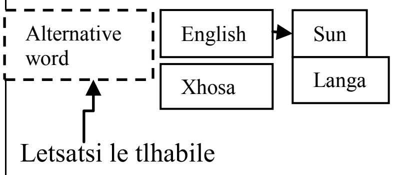


Figure 2. The content presentation approaches

Supporting informal learning content and activities in informal environments

In informal learning, switching between two languages occurs more frequently than in formal learning. Learners would thus need learning content with supportive learning activities which are more flexible towards the use of bilingual learning. Learning content can be designed using the above principles of presenting content to introduce, reaffirm and translate content with the switch between language content occurring more frequently. Informal learning content is often content which emerges from what the learners had already been taught in class. Audio learning activities, such as creating sound clips to reflect the learning content, provide support for the multilingual learning process as they do not restrict how and when the switch occurs between languages. The clips can also be stored under different topic areas which learners can refer back to whenever they need learning content in that topic. The teacher can also monitor the content of the learners. Mobile learning games which are available in multiple languages can also provide support for informal mobile learning. Informal learning chatrooms also provide flexibility in language use, as they do not restrict the learners in the number of times they switch between languages while learning. These features can be used in the development of different mobile learning system to support multilingual learning in both formal and informal environments.

4. CONCLUSION

This paper presents a mobile learning framework for designing mobile learning software in under-resourced multilingual environments, and presents the requirements for understanding the different role-players in this environment. These role-players define the manner in which the software is designed. The framework further describes how bilingual mobile learning can be used to support traditional learning practices in both formal and informal contexts, and can be used as a guide to creating learning content and activities to be used in under-resourced environments. This research has been restricted to a particular South African context, and the paper does not report case studies in other multilingual countries. Perspectives of how multilingual learning occurs in different learning environments will be the focus of future work.

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Short Papers

MOBILE TECHNOLOGY INTEGRATED PEDAGOGICAL MODEL

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ABSTRACT

Integrated curricula and experiential learning are the main ingredients to the recipe to improve student learning in higher education. In the academic computer science world it is mostly assumed that this experiential learning takes place at a business as an internship experience [3]. The intent of this paper is to schism the traditional understanding of equating experiential learning with internships. A model was created and tested in three consecutive years of software engineering classes. This model is based on the integrated curricula concept. A survey was conducted to measure the usability of this model. The results indicated that the students' hard/technical and soft professional skills improved. The paper will first describe the model and then discuss the results of the survey. According to [1] most of the models in this are created for the freshmen where as this model has been created for juniors and seniors who are at a level of extensive independent learning.

KEYWORDS

Mobile Technology, Pedagogy, Software Engineering

1. INTRODUCTION

The fields of science, mathematics and engineering are mathematical based and students are unable to connect the abstract mathematical concepts with real life applications. Recognizing this lack of understanding researchers started to finds ways of connecting mathematics, engineering and science concepts to applications students can relate to. This movement has been termed as the Integrated Curricula. The Integrated Engineering Curricula movement was initiated in 1988 and focused on learning by being able to apply mathematical concepts to real life applications [2]. The concepts of integrated curricula and experiential learning are continually being researched and applied to improve student learning in higher education. Experiential learning is often defined as extraction of knowledge by means of reflection of an experience [3]. According to Jordi (2011) reflection is underlying most learning theories and by applying this concept we are over simplifying the strengths of experiential learning. Most studies on experiential learning are based on Kolb's model [9] . The concept of experiential learning is based on the Kolb's model and Kolb's model is in turn derived from John Dewey's theory of learning. John Dewey's theory was based on wide range of experiences. These experiences can be introduced to the students by multiple means. Additionally, Howard Gardener's theory on multiple intelligences suggests not only do students learn by different means but they can be taught using several innovative teaching methods. One such method is by creating a real business work environment for the students to learn. Based on the theory of multiple intelligences and the integrated curricula an avant-garde experiential learning integrated instructional model was developed.

1.1 Significance of Experiential Learning

One of outcomes of learning is employability. Employers are seeking individuals who are equipped with not only subject specific knowledge but also professional soft skills of communication, problem solving, prioritization and self-motivation. These skills along with the cutting edge technical skills in the field of computer science increase the job opportunities and promote success. One of the faculty have is the translation of theory into practice. Experiential learning offers the opportunity to comprehend the transformation of theories into practice, which is also the basis of integrated curricula. Experiential learning not only focuses on cutting edge technical skills but also on soft skills that are not covered by technical textbooks such as self-confidence and motivation [8].

Most traditional learning takes place by memorization and recollection although the best means of learning is by reading, experiencing and then applying the knowledge [6].

2. PEDAGOGICAL MODEL

This unique integrated instructional model targets the need for experiential learning in computer science graduates. There are several factors that further augment the need to equip graduates with skills that increase their marketability. Some of these competencies are teamwork, collaboration with high productivity, critical thinking, self-learning, prioritizing, problem solving, interpersonal, communication, project management, and analytical thinking. The two outcomes of this model are to increasing interest of undergraduate students in pursuing graduate school and building the ability of students to help them build skills to create innovative cutting edge technical solutions for real life problems. According to [5] experiential learning breaks research barriers in a classroom.

The employers who were surveyed in various studies have identified the competencies such as teamwork, self-learning, critical thinking, problem solving and prioritizing as essential in graduates. These skills have been recognized to be built by ‘doing’ rather than just learning by reading [6]. This model also coalesced the concept of flip classroom. In this model the concepts of the flip classroom are integrated by having the read the chapters on their own and the class time is used for discussions based on **Q**uestion **Q**uotation **T**weet **P**hrase (QQTP). The students prepare the QQTPs and have an interactive discussion. Studies have identified QQTP as an efficient means of promoting lively classroom discussions. Studies have also posited that discussions are crucial to the understanding of concepts. In the traditional QQTP the TP stands for talking points but in this model the T stands for Twitter where the students post interesting facts about software engineering and P stands for phrase where the students prepare a phrase to be discussed in a classroom along with the Question and the Quotation [1].

2.1 Model Description

In this model students work with a business executive as a client and develop an innovative solution for a task as seen in the figure below. The client meets with the students every other week at a business location and shares the requirements of the task. The students dressed in business casual outfits meet in a very professional manner with the client and interpret her task into a requirements document. The client students meetings continue through the semester increasing the frequency of meetings closer to the end of the semester. In the interactions the students not only learn the technical knowledge but also the softer side of professional interactions. Often times the focus of in-class learning is on the hard skills and the softer side of the hard skills is overlooked. This model exploits the opportunity to interact with the client and helps the students develop soft professional skills simultaneously. The critical thinking ability of the students is at peak when the students are trying to problem solve real world problems while having a sheltered exposure to the real business world. In this scenario the students have the scope of making errors and not having to worry about loosing their jobs. As the project develops the students learn to use the business software applications of the real world and learn the etiquettes of interacting with a client and prioritizing their tasks. The student’s analytical skills are sharpened as well encouraging self-learning skills. The role of the professor is to make the interactions as smooth as possible by preparing the students in advance and having post interaction discussions to highlight the dos and don’ts of the meetings. The flip classroom concept is utilized on the days when the software engineering content is taught. The students are instructed to read a certain chapter and prepare a QQTP. During class time students ask their questions, share their quotations and phrases. The tweeting on Twitter is done on their own time as well. Utilizing the QQTP the professor facilitates a live discussion. On the days the Objective C or iOS programing is taught the professor introduces programming concepts using examples and then the students work on a set of labs for the rest of the time. The third day that is used for client/project time is utilized by the students for interacting with the client and or working on the requirements/design documents for the client or on Objective C and iOS programs for the project for the client. The end result is a polished innovative solution to a task provided by the real world business client. A major focus in this model is on innovative cutting edge technology.

2.2 Significance of Innovative Cutting Edge Technology Integration

Computer science is one of the most volatile fields in the curriculum. Technology is evolving overnight and it is essential to keep the students up to the latest developments of technology and equip them with skills that can help then stay a breast with the rapidly evolving technology. They need to have the skills to self-learn any new technology that has come up in order to keep their marketability high. This course stresses on the need to develop skills to stay abreast with the growing technology and the ability to solve problems the most efficient way by utilizing the most cutting edge technological solution possible. Cutting edge technology utilized in the implementation of this model was the iOS platform for the mobile devices.

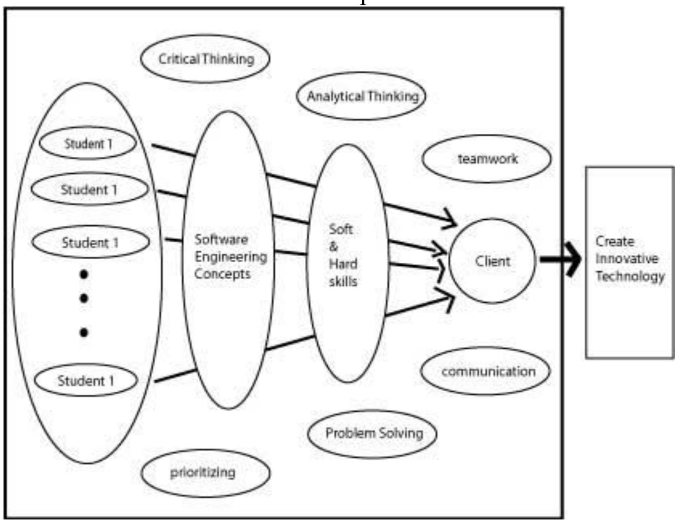

Figure 1. Experiential Learning Pedagogical Model

2.3 Application of the Model- Research Design and Methodology

2.3.1 *Course*

This model has been implemented in classrooms for the last three years for software engineering classes. The first year the client was from a hospital system and the students developed a readiness monitor for the client. The second and third year had the same client helping flush out any wrinkles in the model. As the end of the first year approached the realization that the students can be challenged more facilitated the addition of the innovative technology component to the model. Mobile technology was used as the innovative technology piece for this model.

The students have not only learned the software engineering concepts but also iOS programming. The class meets thrice a week for two semesters in a row. The first semester focuses on software design skills and objective C programming while the second semester focuses on quality assurance skills and iOS programming. In essence the students are learning in two courses the content worth for four courses – software design, quality assurance, objective C and iOS programming. The class meets three days in a week and the first day of each week of the first semester is dedicated to software engineering skills with a flip classroom structure and the second day each week of the first semester is dedicated to Objective C programming. The first day of each week of the second semester is dedicated to quality assurance course and the second day of each week of the second semester is dedicated to iOS programming. The third day of each week of the two semesters is dedicated to client meetings and project time for the students. In this model the students interacted with the client they not only learned the hard skills of software engineering (software design and quality assurance) but also the softer professional skills that employers are seeking in graduates. The strength of this class was 11 students when the data was collected.

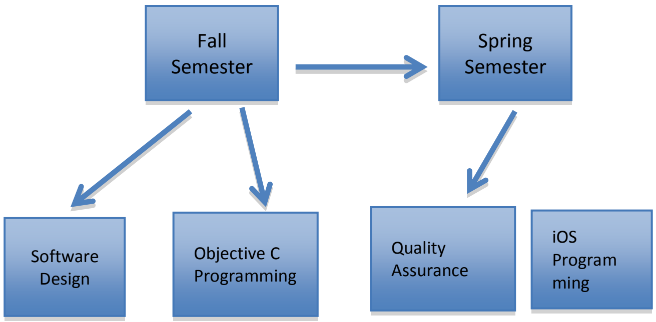

Figure 2. Course content distribution

3. RESULTS

The before and after surveys of the students demonstrated improvement in hard and soft skills. The hard skills measured were the technical knowledge of software engineering concepts and objective C and iOS programming. The soft skills measured where communication and interactions with the client and professional skills all bundled together. Cognitive skill such as critical thinking was also found to have improved.

The graphs below show the improvement.

The students taking these classes were juniors and mostly seniors and hence had a good number of courses in their curriculum covered. They survey results showed that the students felt that they had improved their technical skills in these classes. The graph in fig 3 below demonstrates the before and after of their hard skills with a range of 1 to 5 with 1 being the lowest and 5 being the highest.

Hard Skill

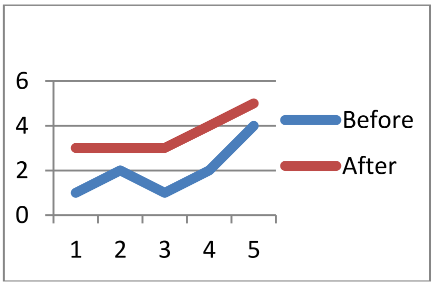

Figure 3. Hard skills improvement

The communication skills were measured ranged from strongly agree(5), agree(4), neutral(3), disagree(2), and strongly disagree(1). The graph in fig 4 below demonstrates that the students improved their communication skills.

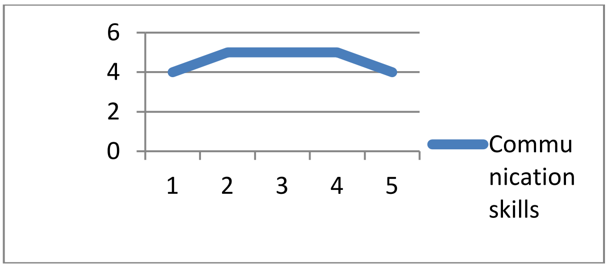

Figure 4. Communication skills

The soft professional skills were all combined into one question ranged from strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The fig 5 below demonstrates that the students improved in their professional soft skills.

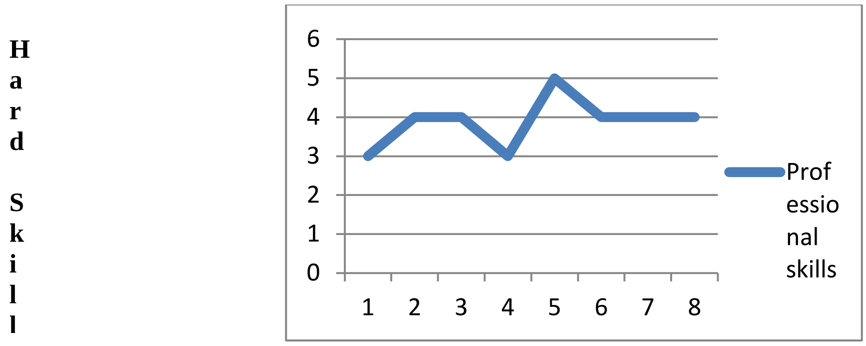

Figure 5. Professional skills

4. DISCUSSION

The creation and implementation of this pedagogical experiential learning model not only demonstrated that students don't have to be outside the classroom to gain experiential learning but also established that the integrated curriculum, theory of multiple intelligences and the experiential learning theory of John Dewey's model can be combined into a contemporary model with innovative technology built into it as an efficient pedagogy. According to the science of learning studies have identified experts such of a field as more knowledgeable than novices and integrating a client in the pedagogical model brings in the expert that can help mold the soft skills as well as the hard skills of the students. The uniqueness of this model is its fusion of several learning concepts and theories to create a comprehensive, all-embracing model that conceives a vision framing the concepts of integrated curriculum, multiple intelligences, experiential learning, and flip class room. The features of each of these theories amalgamate to fashion a model that covers competencies of self-learning, prioritization, critical thinking, self-motivating, problem solving, communication skills, analytical skills and professional skills of interaction. This unique blend of features transforms the tradition theories into a contemporary technology based avant-garde pedagogy that befits the field of computer science. Another important component of the instructional pedagogical research study is its application and usability testing that has been conducted for a period of three years further establishing its reliability.

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REPRESENTATIONS OF AN INCIDENTAL LEARNING FRAMEWORK TO SUPPORT MOBILE LEARNING

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ABSTRACT

This paper discusses how the particular features of mobile learning can be harnessed to provide new informal learning opportunities in relation to context aware and location based learning. The MASELTOV project is developing representations of an incidental learning framework to enable software developers and researchers to both design and analyse learning journeys to support social inclusion and language learning. Visual representations act as boundary objects that enable interdisciplinary conversations and reveal potential issues. Mobile learning offers the possibility of scaffolding the transfer between settings, and we identify location as a key element of making learning relevant to the user's situation. This affordance is illustrated with the example of the application of mobile learning, and in particular, incidental learning, to assist the target audience (recent immigrants) in the MASELTOV project. This project is developing an incidental learning framework which we have used to explore in detail the potential incidental learning journeys which may be undertaken by the immigrants, and in this paper we discuss the current framework, and the challenges in generating representations that support useful debate.

KEYWORDS

Learning framework; context-aware learning; language learning; urban environment; social inclusion; immigrants; location-based services.

1. INTRODUCTION

Mobile learning can help people use their everyday experiences for incidental learning. Clough *et al*. (2008) have described the uses of mobile devices for informal learning that also highlight the importance of place and personal space, as the learners they studied "*deployed their devices in ways that were appropriate to their current physical and temporal context and learning needs*" (p.364). The MASELTOV project - Mobile Assistance for Social Inclusion and Empowerment of Immigrants with Persuasive Learning Technologies and Social Network Services (http://www.MASELTOV.eu/) - is focusing on the use of smartphones as a support for recent immigrants to Europe. The aim is to develop technology rich and socially inclusive learning opportunities for immigrants within cities. The social exclusion of many immigrants can be attributed in part to underdeveloped language skills, hence the project is investigating how these skills may be acquired and developed in informal ways that fit in with immigrants' lives. Learning opportunities can arise in various locations around the city (location-based learning), which also provides new challenges for designers and developers of mobile tools. As a result, new technology enabled learning activities can emerge. For example, learners will have particular needs for support and opportunities for learning in locations such as the bus stop, the train station, the bank, the supermarket or the health centre and they will be able to access this support from their smartphones.

The links between mobile learning, context and location have been commented on by a number of researchers. For example, Kukulska-Hulme *et al*. (2009) write: *Traditional classroom learning is founded on an illusion of stability of context, by setting up a fixed location with common resources, a single teacher, and an agreed curriculum which allows a semblance of common ground to be maintained from day to day. But if these are removed, a fundamental challenge is how to form islands of temporarily stable context to enable* *meaning making from the flow of everyday activity'* (p23). Brown et al. (2010) relate this strongly to location as follows: *'The distinguishing aspect of mobile learning is the assumption that learners are continuously on the move. This is not just their physical mobility, but also how learners are active in different contexts and how frequently these might change, depending on an individual's location.'* (p7). Scanlon (2013) reviews the literature on mobile learning and in particular features of mobile learning that allow for location-based learning (especially in relation to collaboration), describing both location-based and location-aware learning. Nova et al. (2005) describe some systems as location-aware, i.e. '*knowing where the user is can lead the system to trigger specific events or to allow him/her to post messages bound to this specific location*.' (p21). Location-aware learning is an emerging paradigm and our contribution focuses on developing a framework that will support the design and evaluation of learning activities appropriate to the urban setting and target group. Our framework considers a number of dimensions, and considers not only location, but other aspects of context-awareness, such as time, and social resources available; however, we acknowledge location as of key significance when considering the particular affordances of mobile phones.

2. THE MASELTOV INCIDENTAL LEARNING FRAMEWORK

In the MASELTOV project, the concept of the service user's location triggering activity is important, in particular how incidental learning -: "*unintentional or unplanned learning that results from other activities*" (Kerka 2000, p.1) - may be delivered in particular contexts by a mobile service. The project has developed a number of scenarios to consider the range of activity that the service might support. A first version of an Incidental Learning Framework (see Figure 1) was produced to analyse mobile incidental learning in detail and to facilitate the communication of learning designs appropriate to the situation in which an immigrant wishes to use the service (see e.g. Gaved et al., 2012). The Framework considers the place an incident occurs, task(s) the learner is carrying out, the tools the learner uses, the social support that the learner makes use of, the learning outcomes to be achieved and the (relative) time the incidental learning occurs. Both place and time can contain contextual information and social support can include collaborative activity. The target audience has been identified as finding it difficult to access classroom based learning opportunities due to other commitments, and hence mobile learning offers a way of providing better access to language learning resources, as well as being more appropriate to their immediate situation; for example by enabling access to fellow learners at any time, not restricting learning interactions to a particular place, and enabling daily activities to become triggers to learning episodes. MASELTOV's goal of supporting language learning within the context in which it is applied can be seen as a form of situated learning. Mobile devices such as smartphones, with their portability, give the MASELTOV audience the flexibility to learn wherever and whenever they wish to; however, the provision of learning support also needs to take account of the context in which the situation or learning episode is happening.

The MASELTOV support services and tools will be delivered through an app downloaded to the user's smartphone. The MASELTOV app brings location as a context to the fore, along with time. Timely feedback, related to the user's current location, can provide highly relevant content to support their needs or stimulate reflection or further learning. However, given MASELTOV's goal of supporting a journey towards social inclusion and language learning over an extended period of time, 'contextual support' may be relevant not only in immediate response to an action, but also by offering a recommendation that can be acted upon later at a time more suitable for the user to respond. Smartphones, with their network connectivity, computing capacity, and on board sensors, have enabled mobile language learning with multisensory contextual support to become a reality for the MASELTOV target audience. A central concern is to enable effective learning that takes advantage of the tools' ability to recognise the contexts (place, people, and time) in which they are used.

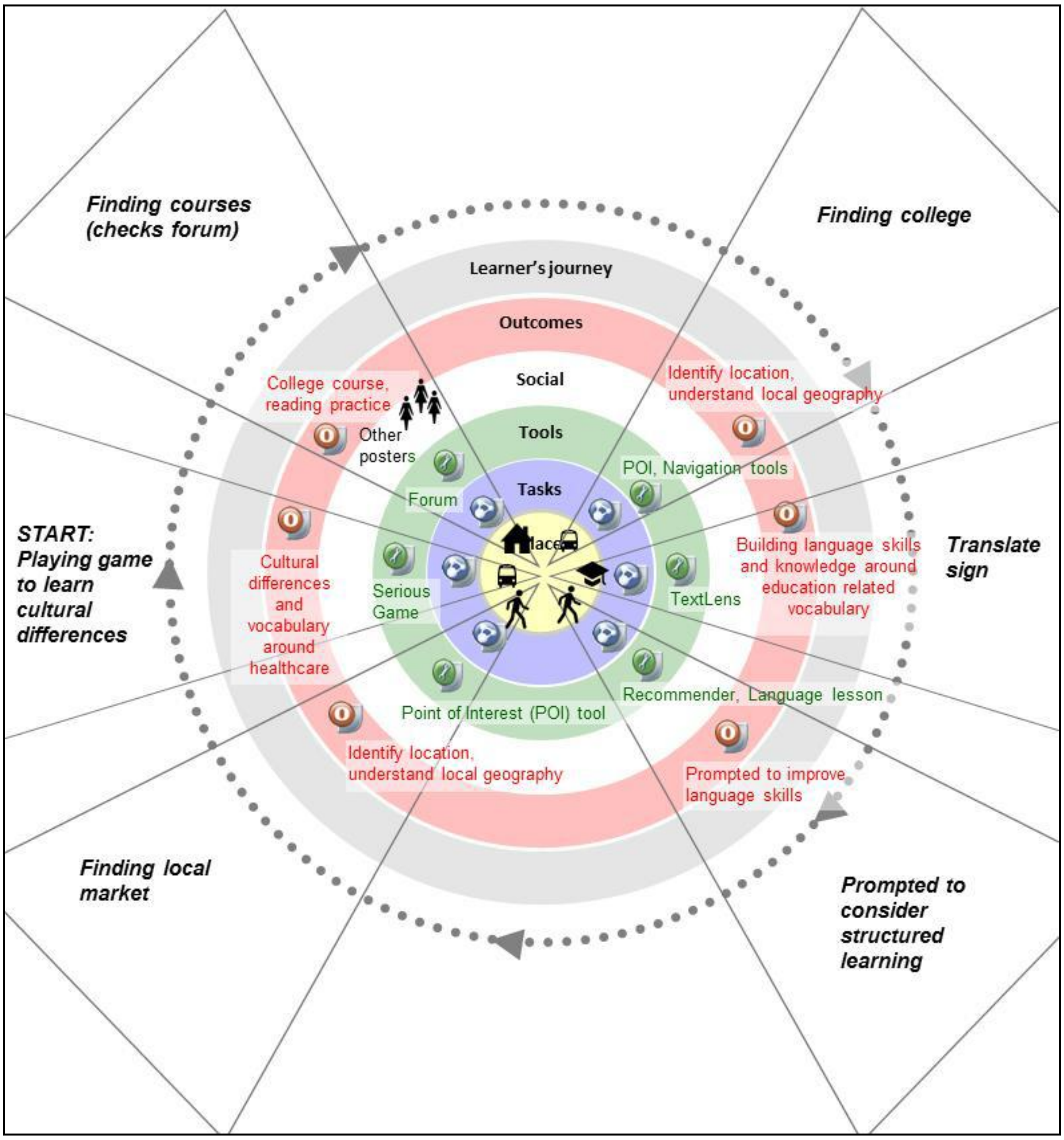

Figure 1. An incidental learning framework for the MASELTOV project describing key elements of learning: places, tasks, tools, social support, outcomes, and learner's journey.

While the original Incidental Learning Framework diagram enabled high level discussion of issues and reflection of what is encompassed by its key elements, a detailed mapping of a learning trajectory could not be sufficiently captured. We have since extended this framework by creating further visualisations to explore each element in more detail; for example Figure 2 unpacks the concept of 'Place' describing the range of affordances that may be associated with particular places that the MASELTOV service user is likely to encounter. It includes a series of questions about a particular place to prompt developers' reflection, whether technology use was acceptable in the location, whether there was an urgent need for support in that location, whether the location offered the possibility of connectivity with wifi or associated GPS, and whether the location allowed for different (time) durations of learning opportunities. This work complements the range of attributes of 'place' derived from studies of informal language learners using mobile technologies (Kukulska-Hulme, 2012), which drew attention to the nature of the place (e.g. public, private) and the mobility of the learner (e.g. stationary or moving). Early work in context-aware computing was largely focused upon the integration and abstraction of data from environmental sensors, e.g. Abowd et al.'s (1997) conceptualisation of a tour guide that would utilise video, GPS, and camera input to trigger context-sensitive resources to provide historical, cultural, or linguistic support. Such early conceptualization have been realised in more recent research due to the presence of a range of affordable and compact sensors built into the current generation of mobile phones. Sensors which derive information about the device's use can also enable contextual support, for example utilising accelerometers in phones to interpret the activity currently being undertaken by the user, and providing suitable resources in response. Bristow et al. (2004) identified that body position (e.g. sitting, standing, or walking) was a key aspect to defining the context of the user when considering what resources were appropriate to recommend to them. Here we have highlighted place as an example. We have also unpacked the other key elements of the framework in other secondary visualisations.

Figure 2. A visualisation of the range of affordances that may be associated with particular places that a MASELTOV service user is likely to encounter during their daily activities.

3. WORK IN PROGRESS AND CONCLUSIONS

We are testing the utility of the framework and its variety of representations in the design of the MASELTOV user's learning journeys. As noted here, features now included in smartphones can support location based and location aware learning in a way that has not hitherto been possible. However, there is a need to develop our understanding of learners' needs when they are engaged in incidental situated learning as part of their everyday lives. The Incidental Learning Framework (ILF) described here is a step towards developing that understanding. It allows us to both analyse mobile incidental learning by considering key elements of learning: places, tasks, tools, etc. and how they come into play in different learning journeys. Secondly it provides a tool for communicating with designers of the tools and services. Testing of the framework has revealed that more detailed interogations of each element of the ILF are required to enable developers to successfully identify suitable learning approaches and resources, and we are currently testing this second generation of representations. Mobile incidental learning has received relatively little attention until recently. However, given the current capabilities of smartphones there is likely to be much more focus on how it might be supported by contextually-aware devices. We expect to refine the ILF further as a result of the MASELTOV field trials in 2014, thereby extending our understanding of mobile incidental learning.

ACKNOWLEDGEMENT

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USING MOBILE APPS AND SOCIAL MEDIA FOR ONLINE LEARNER-GENERATED CONTENT

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ABSTRACT

As part of an evolutionary approach to extending and enhancing the online learning experience for adult students in the LMS-based online college courses that I teach, I have been introducing learning activities that use social media and mobile devices. However, realizing that student adoption of mobile devices with data plans such as smartphones or tablets was still evolving, I focused on the development and use of these resources from a teaching perspective and to test and model it for learner-generated content. With the increasing adoption of mobile devices, I have begun to explore how I can integrate mobile learning activities into the online course assignments in ways that would allow students to use their mobile devices as a means of creating learner-generated content and sharing communications about that process. In this paper, I share my initial, anecdotal findings about this process, identify useful social media and mobile apps for mobile learning, provide examples of their successful integration into online course assignments and activities, and propose methods of further research and development.

KEYWORDS

Mobile learning, social media, mobile apps

1. INTRODUCTION

Overcoming the “distance” in distance learning has been a challenge for me as an online teacher and many of my students since the introduction of online college courses into mainstream educational practice. By distance, I not only mean the physical or geographical distance that can pose challenges to scheduling live online sessions or determining communications that accommodate students in multiple time zones, I also mean the psychological and social distancing that can occur with students who find the virtual mediation of online courses less engaging than the personal interaction with a teacher and other students in live onsite courses.

This distancing effect is also a function of the busy schedules and resulting challenges of most of my adult online students who juggle professional demands of their work and personal responsibilities with family and friends along with their academic work as students. Time management in this context of many competing demands takes on a central place in accommodating this adult learner population when designing online learning activities.

And despite the many benefits of working within a Learning Management System (LMS) as the platform for online college courses, it also imposes some distancing effect in the nature of its enclosed sphere of interaction. Most LMS-based college courses require familiarity and facility with using its online resources, an ability to work with text-dominated course content and communications, and system requirements that favor personal computers over most mobile devices for accessing the course and using its interface.

There are also several constraints on the adoption of mobile devices in online college courses that can be attributed to the still evolving state of mobile technology development, including a wide variety of mobile device attributes such as screen size, and a relative lack of multi-platform standards for development of mobile software. By contrast, there are many benefits in using mobile devices in support of online learning. Adult students with their competing demands on their time, tend to have highly mobile lifestyles in which the adoption of mobile computing associated with smartphones and tablets has represented a perfect match of need with function. With this adoption comes a high level of mastery of use, seamless integration into most personal and professional activities, and a natural preference to use this medium for most communication and computing activities. These attributes of mobile devices make them useful for lifelong learning, distributed learning, field-based learning activities, and authentic learning (EDUCAUSE, 2010).

For many colleges, faced with decreasing enrollments and limited budgets, migrating through LMS-based online course support to accommodate demands of mobile device users often dictates a slower adoption path with limited and specialized support (Alden, 2013). Online faculty who teach with more minimal administrative development of mobile learning support are then faced with similar approaches at the course level.

As part of an evolutionary approach to extending and enhancing the online learning experience for adult students in the LMS-based online college courses that I teach, I have been introducing learning activities that use social media and mobile devices that do not rely on administrative or LMS-provider support. However, realizing that student adoption of mobile devices with data plans (e.g., smartphones or tablets) was still evolving during this time, I focused on the development and use of these online resources from a teaching perspective.

With the increasing adoption of mobile devices among my online students (evidenced in their attributions and the primary use of mobile devices to send me brief email messages – indicated by the ubiquitous "Sent from my _____ smartphone" closing line), I have begun to explore how I can integrate mobile learning activities into the online course assignments in ways that would allow students to use their mobile devices, mobile apps, and social media as a means of creating learner-generated content and sharing communications about that process. In this paper, I share my initial findings about this process by identifying useful social media and mobile apps for mobile learning, describing strategies for their successful integration into online course learning assignments and activities, and proposing methods for evaluating this educational innovation.

2. MOBILE LEARNING WITH SOCIAL MEDIA

As an outgrowth of my professional writing (books, articles, etc.), I created a blog (using WordPress blog software) on my teaching and consulting Web site and began writing blog posts with no certain audience in mind. However, with its highly interactive nature, support of text and audiovisual content, and easy access via the Web with a wide range of device support (including blogging and display apps for mobile devices), it soon became clear to me that I could use this social media platform with mobile devices as a way to extend learning activities outside the confines of LMS-based online courses.

I began writing blog posts with text, resource links, images, and video that addressed topics in the reading. For each blog post, I created a discussion post in the LMS weekly conference area that briefly introduced and elaborated on the topic and then invited (as an optional learning activity) the students reading it to click on a link to my Web site blog that opened a new browser window with that blog post in view. I also invited them to optionally post comments in reply to the discussion post and/or the blog post. Despite identifying it as an optional learning activity, I provided credit for their use of this resource to satisfy part of their discussion assignment requirements. As part of the instructions for blogging, I indicated that for confidentiality, student bloggers should only use their first name and that their email address would not be displayed on the blog (i.e., only used as email notification to approve the post in a moderated blog).

As an extension to their weekly discussion assignment responses, the use of the blog for enhanced learning has been adopted by most of the students based on their posted responses and in the nature of their feedback about the value of this learning activity. One of the interesting results of those informal action research findings was that students understood that in providing comments on the public access blog, that they were becoming co-creators of learning content and interaction not only with their classmates in the current and future course sections, but also with the blog reading public who would view those blog posts.

With the adoption of the blog by online learners, I ventured into the use of microblogging through the twitter.com social media site as an alternative means of providing enhanced learning activities as an extension of their LMS-based course work, I approached the use of this social media resource in the context of a "push-pull" strategy in which I would announce a topic of interest in a brief "tweet" message and include a link to my corresponding blog post (or other information resources on the Web) that would "push" learners (and other users viewing or subscribing to my twitter feed) directly to that source of information. This tended to bring learners into more blog posts of course-related topical interest than what I was directing through my optional discussion assignment posts.

Some of my online learners who were also twitter users would “re-tweet” my message in their twitter feed (to direct those who subscribed to them to the intended posts or sites) and/or tweet a private message to me about the blog post content. Like WordPress, twitter.com also provides apps for mobile devices, so these social media sites re-purposed as extensions to online learning represented an evolutionary strategy for my initial support and use of mobile apps. I am also exploring how mobile microblogging can promote authentic learning among team members in the communications and design of team project presentations in my courses (Hsu and Ching, 2012).

With an increasing need to embed relevant video presentations into my blog posts (and in LMS course discussion posts), I created a youtube.com channel through which I could upload original video and created playlists of existing youtube.com video presentations. Using the online video editor in youtube.com, I could also edit my original video in useful ways (e.g., to control brightness, reduce shake, connect two or more videos into one presentation, etc.). Even when certain LMS platforms made embedding the video within discussion posts or content pages problematic, I could still insert a link to the video (or my video channel site) on youtube.com through which learners could view the videos in a new browser window.

What I began to envision (and begin to realize) was that online learners would use these models of teaching practice with social media sites and mobile devices to offer a similar level of learner-generated content that could be used for their online course activities. And this discovery also made me start thinking seriously about more extensive use of existing mobile technologies that could be integrated into the curriculum with these types of enhanced online learning support, extending out beyond the confines of the LMS platform.

3. MOBILE LEARNING WITH MOBILE APPS

One of my first tests of mobile apps in an online teaching and learning context was in using the mobile app from qik.com to upload live video from my smartphone camera to be viewed as a live Webcast on my qik.com page. Traveling as part of my consulting and writing work (and to present at international conferences) offered opportunities to share live videos of sites, events, and people on my journeys that were relevant to topics that I was teaching in an online course during the time I was traveling.

For example, during two recent pilgrimage walks on the Camino de Santiago in Spain, I used my smartphone to capture live video of how these types of experiences could help people become “untethered” from excessive use and dependence on technology (a topic being covered in my Ethics in Information Technology course). As the qik.com site also acted as repository for archiving these videos, I have embedded videos stored on qik.com into blog posts, such as in my “Untethered on the Camino” blog post on this same topic.

I am also testing other mobile apps at this stage of research and development, such as the popular Skype app and the Voxer app that provide voice communications over the Internet along with use of text, image, and video. Some of the more important criteria that I use for selecting social media and mobile apps for use in mobile learning support are that they are free, easy to learn and use, popular, and have enough cross platform support to be used by as many learners across a range of device types as possible.

4. MOBILE LEARNER-GENERATED ONLINE CONTENT

In addition to learner adoption of the above-mentioned social media and mobile apps to create and share learner-generated content, I am expanding the scope of discussion and group project assignments to accommodate learner-generated content and communications using a broad array of mobile devices. For example, mobile apps and social media can be indicated as a source of learner-generated content needed for a virtual team project assignment. The original project assignment indicates a PowerPoint presentation that is planned and produced through the group chat and discussion forums in the LMS (limited to text messages and attachments of other media). Social media and mobile apps can provide more learner options and control during the planning and production stages as well as for the online presentation.

Discussion assignment responses can also be enhanced using social media and mobile apps in ways that extend beyond static, text-dominated discussion posts to include many of the multimedia attributes associated with these tools. For example, I am planning the use of an alternative discussion assignment for my online ethics course in which mobile device users could post an example of "everyday ethics" in video or still images captured by their mobile device that they observe in events and actions. Using text and/or audio, they would briefly describe the ethical issue and a relevant ethical principle that could address it.

Based on my initial tests of content generation during my walks through national parks and on pilgrimage in Spain, I am also expanding support of the use of GPS-enabled mobile device cameras by learners to tag and log image and video capture so that location information can be presented with that media when relevant to their creation of discussion or project assignment content. For example, they could provide a visual "walkthrough" demonstration of a physical space or event that marks each location of it on a map display with clickable thumbnails of captured video or images that can be viewed at each point on that path.

5. CONCLUSION

With the advantages and limitations already described, I would like to briefly describe plans for evaluating these learning innovations in ways that will guide further mobile learning design and development. Most of my evaluations of these educational innovations have been based on anecdotal data such as unsolicited feedback from learners or through informal action research in which I solicited learner comments about aspects of their learner experience during the early formative stages. With learner adoption and use of these mobile apps and social media in online course assignments involving learner-generated content, it would be useful to evaluate this innovation in formal research (of a qualitative and/or quantitative design) that examines learner attitudes, behavior, and outcomes in a more controlled manner to identify trends and offer understanding of learner motivation and engagement in mobile learning (Chaiprasurt and Esichaikul, 2013).

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TWEETING AS A TOOL FOR LEARNING SCIENCE: THE CREDIBILITY OF STUDENT-PRODUCED KNOWLEDGE CONTENT IN EDUCATIONAL CONTEXTS

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ABSTRACT

In this paper, we will present and discuss data from a research project called MIRACLE, in which high school students learned about energy and energy transformation in a technology-rich learning environment. This learning environment spanned across a classroom, a science center, and an online platform specially designed to support coherence across resources and concepts. During the project, the students tweeted about different aspects of energy and energy transformation. These tweets were based on facts gleaned from previous knowledge or on knowledge that they found relevant during their learning trajectory. This knowledge could be found, for example, in textbooks, on web pages, or on posters in the science center. The tweets were meant to support the students in collecting and creating knowledge content themselves and to gradually increase their understanding of the curricular topic. At the end of the project, the students were asked to write a newspaper article and were encouraged to use their tweets as a source. However, the findings show that the students turned to officially approved knowledge sources when they had to write their assignments. This finding adds to previous studies on college and university students. We discuss the possible reasons for this by examining the lack of established practices for using tweets in schools; more specifically, we discuss how this becomes particularly evident when activities are assessment-oriented.

KEYWORDS

Mobile learning, inquiry-based learning, tweeting, microblogging, museum learning, design-based research.

1. INTRODUCTION

The school system's view on resources for students' learning and education has changed over the last decades. Educators have moved from a more traditional strategy, in which curriculum textbooks and a handful of well-known teacher-*approved* resources were the only thinkable sources for knowledge in use, to a more open-minded view where students are thrown into a pool of *possible* resources. Here, they swim around with some guidelines given by their teachers as lifelines while they search for good resources for their personal knowledge building. In pedagogy today, we have great expectations regarding students' own activities and their independent creation of knowledge as an alternative to or equally important source as traditional textbooks or approved web pages. Taking the students' perspectives into account begs the question: How do they evaluate their independently created knowledge compared to more traditional resources when it really matters and when assignment deadlines draw near?

2. MAIN TOPICS IN THE PAPER

2.1 Objective

The aim of this paper is to scrutinize beliefs about student-produced knowledge and how they are followed up and used across different settings. We follow an inquiry-based approach to learning that emphasizes the importance of activating students and stimulating them to produce content and use this as a resource for later learning (Linn & Eylon, 2011; Sawyer, 2006). However, the data we present and discuss point to some challenges in implementing these ways of working with knowledge in technology-rich environments in and across school and science center settings.

2.2 Existing Knowledge about Microblogging and Learning

Web 2.0 tools such as microblogging have been described as facilitating activities that resonate well with modern social theories on how learning environments in educational settings should be designed. Web 2.0 technologies enable people to collaborate and create knowledge in both large- and small-scale activities, create less authoritative forms of organizing information, give people new tools for inquiring the complexity of a topic of interest, provide new tools and opportunities to publish content and receive feedback from an audience, and offer new modes of representing knowledge and participating in new literacy practices (Crook, 2012).

Empirical research on the use of microblogging such as Twitter or Twitter-like tools in educational settings has also emerged (Ebner, Lienhardt, Rohs, & Meyer, 2010; Junco, Heiberger, & Loken, 2011; Veletsianos, 2012; Wright, 2010; Lowe & Laffey, 2011). Ebner et al. (2010) studied the use of microblogging as a platform for process-oriented learning in higher education. They concluded that microblogging is a new form of communication and that this form of communication can support, for instance, "informal learning through informal communication," "facilitation of student group work," and "direct examination of thoughts and causes of learning" (p. 99). Wright (2010) studied student teachers who tweeted three times a day during a practice period at a school about the experiences of being a practicing teacher. Wright found that they shared thoughts quite impulsively and freely with each other and were encouraged to reflect upon their experiences in developing ways. Lowe and Laffey (2011) studied a group of marketing students that were encouraged to use Twitter in an academic course. They found that the students used Twitter to share relevant examples from public discourse as it appeared in the news or personal events related to the curricular topic in question. In this way, Twitter worked to connect these students' academic lives with what happened in the "real world." Furthermore, in a controlled experiment, Junco, Heiberger, and Loken (2011) found that using Twitter facilitated cooperation among college students, helped them to create links between course material and their own experiences inside and outside of the classroom, and providing feedback in stimulating ways, something that led to increased student engagement and improved grades.

However, reviewing the literature on educational use of microblogging reveals a lack of studies on the use of these tools in lower levels of education (Gao, Luo, & Zhang, 2012). This paper contributes to this void; we provide a detailed analysis of the use of microblogging in a science project that involves collaboration between a school and a science center by analyzing how this tool is used and appropriated in the project.

2.3 Theoretical Perspectives

We employ a sociocultural approach to learning to study these issues. From this perspective, learning is perceived as being situated in a particular practice (Lave & Wenger, 1991; Rogoff, 2003). Learning is not first and foremost about internalizing knowledge or a set of skills, but it is about gaining an understanding of what kind of knowledge and skills are relevant within specific domains and how to use these as tools to competently participate in a specific setting. In order to study how tweeting functions as a tool for learning, it is necessary to study how this tool is interpreted and employed by students and teachers in existing classroom practices. We scrutinize how the content of the tweets is created, how it is elaborated, and most importantly, how it is valued compared to other resources that are available at different moments in the social practice under consideration.

2.4 Method and Context

The data in this paper are collected in a design-based research project (Sandoval & Bell, 2004) called MIRACLE, in which high school students learned about energy and energy transformation in a technology-rich learning environment. In this project, students participated in a learning environment that spanned across a classroom, a science center, and an online platform specially designed to support coherence across resources and concepts. The project focused on three distinct research interventions that aimed to support students' learning of scientific concepts (see Vygotsky, 1978), the coherence between resources (see Ainsworth, 2006), and the relation between schools and science centers (see Gutwin & Allen, 2012).

A class of 32 first-year high school students participated. Data collection lasted for six weeks during the spring of 2013. In total, the data consist of about 60 hours of video footage of the students,' teacher's, and science center guides' interactions. The data further consist of the students' tweets, news articles the students wrote, individual interviews with some of the students, and resources that were part of the science center exhibit.

The students worked in groups of five or six. Four out of six groups were selected as focus groups and were video-recorded. During the project, the groups tweeted about different aspects of energy and energy transformation as a way of collecting and creating knowledge content and gradually increasing their understanding of the curricular topic. The tweets were supposed to serve different functions in the project. The activity of tweeting was introduced to foster coherence in the students' learning trajectories across concepts, resources, and learning contexts. Composing the tweets was a process of searching for and identifying relevant content from less relevant content. In this regard, we argue that this tool has the potential to condense or concisely sum up academic material not just for individual groups, but for the whole class. To emphasize the value of sharing and building upon one another's tweets, we designed sum-up sessions where the students were invited to share their tweets in plenum both at school and at the science center.

At the end of the project, the students were asked to write a newspaper article. The students wrote their articles in pairs, and the best article was printed in the local newspaper alongside a photograph of the winning pair of students. In total, the students produced 15 news articles. A crucial aspect of the project was that the students were encouraged by the teacher to use the tweets they had composed during the project as resources when writing their news articles.

We wanted to investigate how the students used the self-produced knowledge objects that the tweets represented when writing their newspaper articles. In order to do this, we analyzed the tweets alongside the interaction data (where the students are discussing what to tweet about and how to present the tweets for the rest of the class). We systematically searched for how the students referred to the tweets in the video footage and how the tweets appeared in the students' newspaper articles. Further, in the interviews after the project was completed, we asked the students about the activity of tweeting and using the tweets when writing their articles.

2.5 Results

As a starting point for our analytical work, we cross-referenced all of the tweets produced during the project with the final news articles, the informational posters, and other types of relevant resources that appeared in the science center's exhibit. We then scanned this data against open online sources using the software program Ephorus. During this process, we were unable to identify any *direct* relation between the tweets and the student-produced articles; however, this process pointed us in the direction of which online resources the students had used when writing their articles. Primarily, they used online encyclopedias and web pages from companies and public agencies devoted to the topic of energy as resources. However, the majority of the articles did not cite the online resources directly—only three out of the 15 articles contained citations from web pages. When investigating to what degree the content matched the web pages, we found a 4-25% match in five of the articles. In other words, this part of the analysis showed that the majority of the students did not directly use online sources as resources when writing their final news articles, and more importantly, that the students did not explicitly use the tweets they produced during the project.

When scrutinizing the data from the interviews and the video footage, a more complex pattern emerged—how the tweets were used. First, all of the groups produced tweets at different moments during their trajectories. For example, they turned parts of the content from the science center exhibit into their own produced knowledge through tweets. Second, they brought up the content of these tweets during the plenary sessions, in which the students discussed specific topics connected to some of the themes addressed in the tweets while others were overlooked. Several of the students explained that the sum-up sessions with their teacher and the rest of the class created situations where they were provided with the correct answers, but also facilitated interesting discussion topics and allowed them to look at the other groups' work. However, it is worth mentioning that these settings in which ideas were shared were strongly teacher initiated, and the content of these discussions was hardly evident in the students' articles.

Third, the tweets the students produced during their learning trajectories were later accessible at the school; further, the teacher mentioned them and encouraged the students to use them when doing further work on the subject. In spite of this encouragement, we found that the students employed the tweets to a limited extent when writing their articles. That they could have used the tweets as resources even came as a surprise to the students when they were confronted with this issue during their individual interviews. Many of them simply were not attuned to this possibility. Yet, a few of the students were oriented toward the tweets when writing up their articles, arguing that they considered the tweets a potential resource. One student said: "we found it [tweets] useful, for example, when we were writing the article, cause the information was about the same, we made use of it, we had a look at . . . some of the old tweets we had made." However, those students who reported that they looked through the tweets when working on their articles primarily considered their own groups' tweets and only afterward considered the tweets from the rest of the class. If they looked at other groups' tweets, it was mainly for inspiration while working on their own articles. Other students again reported that they were conscious of the tweets, but left them out. As a follow-up question, we asked one student if he relied on the tweets when writing his article, and he said: "No, not directly. I read some tweets about water for my article, that's it, I didn't use so much, but read through just to see what information I could use in my article."

Finally, the majority turned to the internet when writing their articles. One student explained this as follows: "Because that's what we always do, when we are to find out something in a class then it is like; 'use the textbook or internet,' we are told, and then we go online and use the internet instead of thinking a lot for ourselves." As tweets are not an established resource in school, and the project asked students to mobilize previous knowledge about the topic and their experiences from the science center visit, the students may have found it challenging to make use of these types of resources when writing traditional assignments, instead resorting to well-known resources. The students used their textbook frequently. They also used even more popular sources such as Wikipedia and online encyclopedias.

3. CONCLUSION AND IMPLICATIONS FOR FUTURE RESEARCH

In this short paper, we analyzed how tweeting is used and appropriated as a tool for learning in a science project. In line with Ebner et al.'s (2010) study of students in higher levels of education, we found that tweeting seemed to help our high school students focus on tasks and facilitated their group work both at school and at the science center. However, if looking at the practice of sharing and building on each other's ideas, Wright's (2010) student teachers; Lowe and Laffey's (2011) marketing students; and Junco, Heiberger, and Loken's (2011) college students all seemed to be more willing to initiate and share ideas more frequently than our high school students. Their students were less reliant on their teachers' ingenuity than our students were. There are several possible explanations for these different results. Many of these studies investigated the use of Twitter, whereas in the MIRACLE project, we investigated the use of a tweeting tool created specifically for the project. This means that the tool was unfamiliar to the students and more structured within the framework of this project, whereas Twitter is normally part of a more open ecology of information flow. Furthermore, there are reasons to believe that the college students had a greater interest in sharing and integrating tweets into educational activities since using Twitter was a part of their self-elected academic courses.

The main research question we raised was how students evaluated their independently created knowledge compared to more traditional resources when it really mattered and when assignment deadlines drew near. There is one crucial issue that differentiates our data from that collected in the other studies: the assessment element (the very fact that the newspaper articles the students wrote were evaluated and graded). We have reasons to believe that the students did not wish to risk using their tweets in graded assignments. Moreover, their school's assessment practices are challenging in regard to evaluating the quality of knowledge that does not have a direct link to the curriculum or other approved sources. Finally, as many science center and education researchers have documented, there are limited established practices for how to bring knowledge from a science center back to a school (see DeWitt & Osborne, 2007).

Microblogging might be a powerful tool for developing educational approaches that are based on students' knowledge production as part of inquiry-based learning; however, it is necessary to establish clear criteria for what counts as valuable and credible content in such learning environments to make the working conditions predictable for the students. In addition, if we wish for better implementation of student-produced knowledge objects in all phases of their learning trajectories, we must work toward establishing practices in which student-produced knowledge, in addition to already defined knowledge, is seen as valuable and subsequently becomes a more natural and integrated part of the formal school culture.

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WHAT MOBILE LEARNING AND WORKING REMOTELY CAN LEARN FROM EACH OTHER

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ABSTRACT

To a large extent, developments in the workplace and in (especially formal) education still take place independently from each other, regardless of a strong (market driven) demand to bring both closer to each other. The divide is especially visible when looking at developments towards e-working (telecommuting, …) on the one hand and developments towards and in e-learning (online learning, mobile learning, …) on the other. Nevertheless, mobile learning and working remotely (telecommuting) share a number of concerns as well as a potential for a paradigmatic shift in what we expect as their output. In this reflection paper we explore how experiences and good practices from both domains can be put to work in an overall move towards a more innovative society. The key, it turns out, is not an either/or but a flexible organization in which a blend of face-to-face and distance interact in a truly mobile context in which learning environments are designed as knowledge workplaces and workplaces as learning environments.

KEYWORDS

Mobile learning, working remotely, telecommuting, innovation

1. INTRODUCTION

February 2013. Yahoo! announces that it will shut down its remote-work program. While it would be all too easy to dismiss this as 'back to old style' (reportedly, Yahoo!'s offices increasingly look like those of young tech startups) the move is not without significance and importance. Marissa Mayer, Yahoo's CEO, defended the decision claiming that "people are more productive when they're alone," but "more collaborative and innovative when they're together." Regardless of her (disputable) premise –new technologies give a radically different meaning to 'together'-- it is important to understand that the aim of the decision is really innovation.

In education as well we notice trends towards innovative thinking, away from an emphasis on the sheer bulk of readily available information/knowledge. Ubiquitous internet access is increasingly taking care of that aspect of our cognition. Not only does the internet make this possible, it also does this at a time when the exponential explosion of available (scientific) knowledge pushes most learners to the limit (or even beyond) of the capacity of their memory. The shift is towards more encompassing competences, still including knowledge but stressing the importance of skills and attitudes. In education as well, innovative thinking is increasingly seen as a major value across different domains and levels.

Laura Vanderkam's reflection on Yahoo's decision, "Home vs. Office: Where should you work?" (Vanderkam 2013) could therefore easily be paraphrased as "Home vs. School: Where should you learn?" In both cases the question remains whether 'versus' should be taken to mean 'either/or'. We contend it shouldn't.

2. WHENEVER YOU WANT, WHEREVER YOU WANT?

In mobile learning, "whenever you want, wherever you want" is a leading theme, crystalized in concepts such as just-in-time learning – delivering training (also or especially to workers) when and where it is needed. This should not be mistaken to imply that the role of technology in delivering information where and when it is needed will turn learners into autonomous participants in lifelong, learner driven, project based learners. As Margeret Riel rightly points out "Education implies a plan that integrates learning into larger intellectual frameworks that will serve the learner in immediate and generative contexts. This requires dynamic teacher-student interactions around an integrated course of knowledge and skills, with the structure influenced by forces in the economy, academy and community." Classrooms are being transformed into learning communities which can be local as well as geographically dispersed. (Riel 1998)

It is obvious that such paradigmatic shifts in the design of courses and programs will have an effect on the design of learning environments, both physical and virtual. That effect has not yet fully materialized –many (if not most) virtual learning environments still mimic the structure and elements of traditional face-to-face teaching—but interesting projects are being launched. In 2012, Paul Kim, Chief Technology Officer and Assistant Dean of Stanford University's School of Education offered an online course on designing a new learning environment based on the observation that "we construct, access, visualize, and share information in very different ways than we did decades ago" In this course (as in other online courses), students work together in teams with people around the world. The aim is "to design and develop an application or system that combines team interaction activities and learning support features in ways that are effective and appropriate for today's computing and communication devices." (Kim 2012)

Learning environments change, but so does the workplace. 'Workplace," of course, does not just refer to offices, but let us focus on those even though warehouses, workshops and studios offer extremely interesting environments to explore mobile, just-in-time and situated learning. In line with Taylorism, the late 19th century brought corporate board rooms, offices for managers and an open factory-like floor for common workers, reflecting a breakdown of work in increasingly more specific and repetitive tasks. While cubicles, first introduced for the growing group of middle managers in the 1980s (and later generalized for most office workers), offered more privacy, they also discouraged social interaction. As communication became more central in the operational models of organizations, designers started to focus on office ecologies offering a variety of spaces shared by all – ideally including shared desks, cubicles, silent areas, cafeterias, meeting rooms, … (not unlike some aspects of the physical and virtual learning environments explored in education).

However fascinating, for lack of proper design, space, budget … such offices are in practice often far from ideal for a number of reasons including any number of the following:

1. Noise (and headsets to shut it out)
2. Constant Interruptions
3. Lack of privacy (listening in on telephone conversations, computer screen, …)
4. Forced social interaction (unless you accept to be the odd one out)
5. Odors (perfumes, deodorants, food, …)
6. Lack of 'personalized' space (pictures, flowers, …)
7. Avoidance behavior (coming in early, staying late, sneaking in over the weekend, …)

Gensler, Art and Drue Gensler's architecture and design firm (operating offices in 43 cities in 14 countries and who's realizations include the Shanghai Tower), was looking for research to support their design decisions (in that respect reconnecting with Taylor) and initiated surveys in the US and the UK, hoping for insights in the nature of work in an era in which the "knowledge economy is powered by individuals and teams creating organizational value and driving business performance" with "ideas, information and expertise" as "the new currency of business success." (Pogue 2009) The Gensler 2008 Workplace Survey clearly indicates that an environment supporting the four work modes of the knowledge workplace—focus, collaboration, learning, and socializing—offers a definite competitive advantage and a measurable ROI.

As even Marissa Mayer, Yahoo's CEO, concedes: people are more productive when they are alone. This is a recognition of the importance of the 'focus' aspect of the knowledge workplace. Working from home is an important tool to accomplish this. Jason Fried and David Hansson, in Remote –their experience with and perspective on the advantages of working remotely – point out that few people refer to "at the office, in the afternoon" as the place and time where and when they can really get work done – hence coming in early, staying late and sneaking in over the weekend. But they acknowledge that 'home' as an alternative may not be literally 'at home' where television, children, chores, and errands may be as interruptive and intrusive and interruptive as co-workers in the physical office. Home may be home, or a café, or a park. (Fried and Hanson 2013)

Increasingly, the question is not just about the false dichotomy 'office' or 'home' but about finding the right mix of physical and/or virtual environments and about using the right (virtual) tools and about using them right. Using them right may mean not reading emails for a few hours or setting up your phone to ring anyway when a specific someone calls you even though you turned it to silent in order to focus on a difficult task. It also might mean not to hesitate to go meet people face-to-face when you think the blink of an eye or a slight hesitation in an answer might be significant and important. That flexibility too is mobility.

3. VIRTUAL LEARNING ENVIRONMENTS AS REMOTE KNOWLEDGE WORKPLACES

How, if at all, is a learning environment different from a knowledge workplace? Traditional classrooms are, in a sense, often not very different from shared workspaces: filled with noise (there is almost always someone talking, often a teacher), with constant interruptions (calls to attentions, instructions), no privacy, forced social interaction, odors, no room for individualized space, together resulting in avoiding behavior (from showing up late to skipping class altogether).

Bakker and Akkerman point at 4 aspects of boundary crossing between (a traditional) school and the (traditional) workplace: identification, coordination, reflection and transformation all of which they qualify as learning processes. Identity involves conceptual issues such as defining one's professional field, one's role within that field, or even symbols related to those. Identity may also be physically defined by walls. In the workplace, other attitudes are expected. Coordination involves competency profiles, portfolios and assessments which bridge work and schooling. Interestingly, they point at the use of mobile devices as physical tools which are used cross the school/work boundary. Complex reflexive processes lead to perspective making and perspective taking. Here as well, Bakker and Akkerman point at mobile technology such as smartphones to facilitate that process. Transformation is the process in which boundary crossing has an (innovative) effect on both school and workplace. (Baker and Akkerman 2014)

In the context of this paper, we specify 'school' as 'mobile learning' and 'workplace' as 'working remotely'. What we are looking for is how identification, coordination, and reflection can transform mobile learning and working remotely through a process of boundary crossing. Mobile learning, from this perspective, is not just about "whenever you want, wherever you want" but about the opportunity to move around to find (as in the case of the knowledge workplace) the right physical and/or virtual environment. Mobile learning is also about using the right (virtual) tools and about using them right. This may include some (admittedly difficult to accomplish!) autonomous participation in lifelong, learner driven, project based learning but may also mean taking learning to the (on site or remote) workplace or to watching –undisturbed--a videotaped or streamed class rather than attending it physically. Mobile learning may also refer to virtually sharing an annotated document with colleagues, to creating your own learning objects (and sharing them), to setting up a video call with an expert on another continent in another time zone, to stripping a car in your backyard while using a tablet to look up on the internet whatever there is to see or to know and to mapping the pictures in your online driver's license course to a dozen cars and traffic situations.

In the mobile learning environment, just as in the knowledge workplace, the right mix of focus, collaboration, learning (as in memorizing and other cognitive and metacognitive operations that support understanding and comprehension, memorization, retention and recall), and socializing is essential. An interesting observation: we noticed that geographically close adult learners, participating in an eLearning program, started to organize themselves physically as a group, meeting for example in the cafeteria of the school, each working at their own pace, but interacting in very different ways than would or even could ever be the case in a classroom. That too is mobility.

4. CONCLUSION & AFTERTHOUGHT

'Office & school' vs. 'home' is a false dichotomy, masking the need for dynamic and rich environments (whether a 'learning environment' or a 'workplace' – that too is a false dichotomy) in which focus, collaboration, learning, and socializing all have their proper place, taking into account strategic and operational personal and organizational goals, individual characteristics of people, and the lever of the spur of the moment. Mobility is an important tool to accomplish that dynamic equilibrium, made possible and supported by technology. Mobility makes us flexible and flexibility is what we need in the complex and dynamic environment which is ours.

An afterthought. Commonly voiced concerns about mobile learning (as an extreme case of eLearning) and remote working include issues related to authenticity, especially in certifying courses and programs, and even more so when certification has a civil effect such as access to a profession or career advancement. Other concerns relate to value. Employers are concerned they will not receive value for their money and students worry about getting value for the money they paid, perhaps implicitly or explicitly assuming that what tuition is paying for is really teacher time in front of a classroom (what else could it be for: so much online information is for free!). There are more. But a common theme, it appears to me, is trust. Trust that workers/learners like to work/learn, like to be proud of what they accomplished, and like to contribute to reaching goals. Trust is an essential element in a human society and the fact that we can trust and distrust is in itself an evolutionary indication that trust should not be unconditional. In the absence of trust we have to face our fears. Often fear is related to what is new and unknown. Much of our concerns about mobility – mobile learning as well as remote working—find their origin is what we most of us are used to: a 9 to 5 job/education in a familiar environment. Leaving that trusted environment, literally, may not be easy. Look at it this way: you never get far by staying where you are.

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IN-TIME ON-PLACE LEARNING

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ABSTRACT

The aim of this short paper is to look at how mobile video recording devices could support learning related to physical practices or places and situations at work. This paper discusses particular kind of workplace learning, namely learning using short video clips that are related to physical environment and tasks preformed in situ. The paper presents challenges of supporting learning as part of work practices taking place in the workplace, because learning has different attributes during work than in formal educational contexts: e.g. it is informal, just in time and social. The theoretical framework of the design is the tradition of pragmatism. We start with the concepts of experience, change of practices / habits and reflection, claiming that living through experiences suggest changes for practices and these trigger reflective processing of the situations. We present an Android application 'Ach So!' for creating and annotating short videos as potential solution for informal learning for physical work practices. The paper ends in proposing future steps in the development of the application. The co-design process for the application is lean and iterative, where the design receives feedback from the project partners, skilled workers, apprentices and managers of SMEs targeted to be the main users of the application.

KEYWORDS

Workplace learning, learning through experience, video, Pragmatism, android, semantic video

1. INTRODUCTION

The aim of this short paper is to look at mobile video recording devices and apps and their potential to support learning that is related to physical places, practices and situations at work. Since it has already been shown that learning is different during work than in educational contexts, e.g. by being informal, just in time and social (Kooken et al., 2007, Kerosuo and Toiviainen, 2011), this paper is not focussing on the general aspects of informal workplace learning, but goes directly into the discussion of particular kind of workplace learning, namely learning using short video clips that are related to specific locations and physical environment. The paper starts with a brief theoretically oriented discussion about challenges related to workplace learning and pragmatism notions of experience. The frameworks have been selected to be the bases of the design research, because of their relevance in a process tackling multifaceted challenges like the one in hand. We continue with a presentation of an Android application named Ach So! that has been designed as part of the research. Ach So! is an app for creating, annotating and sharing short videos of situations in a workplace. We demonstrate the main functionality of the app and the first impressions of using it. The paper ends by proposing future steps for the design and development of the application. The work is supported by the European Commission 7th Framework Programme project Learning Layers (LL), which is developing a variety of tools and applications for supporting learning at workplaces. One of the pilot areas of the project is construction sector, in particular the sustained ecological construction sector. The development and co-design process for the application is lean and iterative, where the design can receive feedback from project partners, skilled workers, apprentices and managers of SMEs, who are the main benefiters of the project.

2. BACKGROUND AND CHALLENGES

The learning we are interested in is tied to the context, actions and practices or work and learning, where use of various tools and physical artefacts play an important role. Often this type of work is multi-episodic: problems arrive and take place in time and the need to learn and to know occurs within the work process. Learning at work is time and context situated (Kerosuo and Toiviainen, 2011). One of the possible solutions for the situated work learning, discussed in various forums of researchers and practitioners, are mobile and ubiquitous learning environments (see e.g. Hernández-Leo, Ley, Klamma and Harrer 2013).

Videos have been used in workplace learning since the beginning of video technology. Cennamo (1993) proposes three sets of qualities for educational videos: 1) content of the video 2) characteristics of users 3) characteristics of the task, namely why and for what purpose the video is used. Depending on the three qualities of the videos and their use, they may provide benefits for learning or make it more complicated.

When studying construction work, we observed that often learning is understood as growing of the repertoire of solutions and ‘tricks of trade’ that allow the worker to work efficiently. For educational construction work video content this means that the content should be practical, not theoretical or abstract. Since the users are both problem and solution oriented, good examples will be tested out right away and failed and successful attempts to do things could be used as content for others. Furthermore, the tasks in a construction work are in such scale and speed that the ways to execute actions, usage of tools or materials can be captured on video without special technology. These are aspects that support the idea of using video clips in informal learning in construction work.

In this study we focus on the construction sector for finding practices to support workplace learning. The main challenges in these working environments are: tight schedules – no time for dedicated learning or practising, short moments were the guidance or support for changing practices or learning new usages of tools and materials arise, and often harsh conditions where it is not easy to use devices that require fine motor control, e.g. touch-controlled smart phones.

One of our assumptions is that learning and reflection is more efficient when it occurs close (physically and temporally) to the practices itself (see also Mørch and Skaanes 2010). To meet the needs the mobile learning application has to be able to show contextual and situated practical skills and knowledge, and be easily available without breaking the execution of the work practices too gravely.

3. PRAGMATISM NOTIONS ON EXPERIENCE

In our design research we study how video capturing and usage of the video could be used without disturbing the primary work practices. Furthermore we do research on annotations, possibilities to enhance reflection that occurs afterwards or directly when using the videos. As part of the research we design prototypes to test our ideas.

To guide and scope the design, we started with three concepts (1) experience, (2) change of practices / habits and (3) reflection. The concept that ties all of these three parts together is meaning making: living through experiences that suggest changes for practices and trigger reflective processing of the situations. Habit (habituated practice) is related to the concept of belief and doubt (see e.g., (EP 2:19 [1895]). Beliefs can be such that we are necessary aware of them (EP 2:12 [1895]) or but they can also be something that can also go unnoticed – be unconscious (EP 2:336 [1905], CP 2.148 [c. 1902] and CP 2.711 [1883]).

Bergman (2009) clarifies that beliefs can be seen to be “intellectual habits” that “*might not be in the focus of our awareness but which can be easily brought up into reflection”*. This easier bringing them to awareness distinguishes them for instance from tacit knowledge, which is related to automated routines that are hard to explicate. The problems of learning tacit knowledge are widely studied and discussed for workplace learning (Nonaka and Takeuchi 1995 and Zhenhua 2003).

Physical practices are present for awareness and observation. Most of the physical aspects observed and of which one is being aware of are external. They provide common ground for meaning making. The process of going through what has been executed, what is right or wrong or felt in a different manner etc., is clearer when it is possible to refer to it physically. When it is possible to point to the indices that are common for the persons present and from which they may have similar kind of experiences. This is the core in tutoring processes, namely, showing the important points, practicing together, using a tools or materials. It is experiencing together. It underlines the challenge of recording a real occurrence in such way that the material clues are visible. These clue-like characteristics in the surrounding artefacts emphasize the context, common ground, potential for sharing. We still need to ponder on the question: what invokes learning from the daily routine, from process or habit? We shall argue that it is changing practices through experiencing.

When observing construction work we recognized that while working people enjoyed moments of doubts and inspiration. Often this kind of feelings are described as irritating; feeling uncomfortable before realising from some clues what is different or needs different kind of actions. The emotional, bodily and routinized aspect of habit is tied to embodiment – being and acting in place, but it also provides a different view to the reasoning, reflection and learning itself. Dewey's concept for instinct is *qualitative immediacy* (see e.g. Alhanen 2013). The qualitative immediacy is the specialty in experiencing within time and place — it is the something that belongs to the particular experience. Often this is felt, as something being wrong, but it's not possible to tell what is wrong, although it is noticed. These experiences are seen to be the triggers where the *potential for learning occurs*, which can be enhanced by right kind of tools such as video capturing tools. (See Bauters et all. 2011).

Skilful performance of work practice, allows reflecting the practice while performing it (Schön, 1987). Reflection and self-controlled conduct characterises Peirce's concept of habit. These emphasise the rational aspect of habit. The instinctual or automated bodily aspect of habit as mentioned earlier relieves consciousness to the more demanding tasks (see also Kilpinen 2009:17). Schön's reflection-in-action (1983) and Boud et al. (1985) model of reflection are two modernisations of Dewey's concept of reflection that caused a reflection surface the discourse again in 80's. Schön's reflection-in-action provided a new way to describe the on-going learning of a skilled practitioner as a reflective practitioner, and the idea was applied to the goals of art, design and professional education (Schön, 1987).

Our observation during the design process point towards technology to capture the moments where experience tells that something interesting is on the way. Technology should support this kind of alertness towards experiences that suggest changes for practices. Technology should scaffold reflective processing of such situations in ways that are recognizable as beneficial, and worth the unavoidable pause or delay that the capturing of the moment may cause. Videos are good artefacts to share the concrete and emotional aspects of experiences, and they can be used as indices through which it's possible to perform joint meaning making. The possibility to leave a temporary or digital mark to artefacts supports the meaning making, which again provides more clues (indices) for referring back for further reflection or shared meaning-making.

4. SHORT VIDEO CLIP CAPTURING APP

Ach so! is designed to lower the barrier for using video to capture learning and to record events that others could use for learning. It aims to introduce these as useful practices at construction and training sites. Ach so! provides an app to introduce the process of using videos for learning. The tool is for recording and annotating video clips for learning in construction. It is implemented as an app for Android platform, to be used with tablet computers or smartphones in construction sites or training sites (see Figure 1). In 'Ach so!', the users record short example videos in four genres, 'Site overview', 'Problem', `Good work` and 'Trick of trade'.

Figure 1. Screenshot from video clip captured by Ach So! showing annotation playback and editing interface.

Videos can be connected to real world objects by linking them to nearby QR-code or barcode, or by using the location coordinates. Ach so! videos in current implementation are sent to SeViAnno-platform (Renzel et al. 2010), where they are stored as MPEG-7 annotated videos. Stored videos include automatic metadata: location, date and author and optional QR-code, tags and annotations. The annotations are added by touching an area on a paused video and writing the annotation text (Figure 1.). The annotations appear in video timeline as jump points, and when playing back an annotated video, the video automatically pauses for three seconds for each annotated target. This pause is to encourage creation of short clips, where important aspects in moving scene are shortly explained. The purpose for storing video annotations and descriptions as MPEG-7 semantic data is to later support semantic recommendations for video metadata and for clips to watch.

5. FEEDBACK FROM THE FIELD

Feedback has been acquired through small incremental testing in the laboratory type of settings with design group's members and associates trying out the application, but also with two small field experiments in actual work settings. The feedback in both cases caused immediate redesigns of various features. Next we describe the feedback and directly after that discuss what kind of changes it caused.

The first field test after many user interface tests within the design groups was to visit an office building intended for the future site for the research group. The idea was to get to know the place, present it for the rest of the team and start planning the usage of the rooms, placements of the furniture, and people. First things that were noticed were that the four initial genres were not suitable for freeform experimenting with the app. To give an easy genre for playing around and starting the use of tool, especially in construction context, we replaced genre "Don't do this" with "site overview". Furthermore, the genres were indicated with symbols, but these were hard to memorise, so they were changed into wording/titles. We also found that the user varied often between landscape and portrait recording stance, though in that version only landscape was properly supported and there was an initial decision to support only landscape format. We decided to make the application to work also in portrait mode, and take care that the player interface has sensible layout when the screen is rotated.

The second field test was with an environmental engineer, who went to swamplands to build measurement and monitoring stations. This was testing in harsh environment during a typical, though challenging work task. Physical limitations with mobile phone recording were found. For example, if the worker is alone the recording is impossible in the harsh winter conditions: hands are too wet and air too cold to operate well the smartphone and most of all the work has to be stopped. However, many moments were recognized by the engineer doing the testing where capturing "how to do things" would have been very beneficial for later guiding of other workers. With two workers on same location, it was found that still there was not enough time to stop the work, and sometimes the spaces were the work occurred were too tight to fit the other person to capture what the other one was doing. Finally the engineer team succeeded in capturing a video of a part of work execution. This capturing was executed inside, where the work was easier to stop, where the items could be arranged for capturing. However, the engineers stressed that this kind of capturing and very light and easy adding of annotations onto the work done, seemed to be something they could use to guide inexperienced workers to pay attention to small details when pre-building stations elements for outside set up. The small details are such that can create a lot of extra work if not built properly.

The engineer recognized the need for easy to use "camera" or capturing tool, and also the need for explaining details through annotations, but the designs should support cameras that leave hands free. The next versions try to combine clip management and annotation through mobile device and recording through wearable cameras, on chest, in helmets or in glasses.

6. CONCLUSION

'Ach so!' supports the creation of short video clips that require minimal preparation, but deliver something that is useful for peers to learn in the work community. We have preliminary results to believe that there exists moments in work where people recognize that the moment would be useful to record and share. These moments are either directly related to learning, or they are recognitions of problems, which in turn are related to learning. App like 'Ach so!' allows to take action in these moments, and at least encourages to evaluate the moment from perspective of learning. Thus, the framework and idea is in the right direction. However, to have the video capturing and annotation application in a smartphone or tablet is not the most convenient solution for construction work executed in field in harsh conditions. It means that we have to move forward into the technology of smart glasses and helmet cameras but keep the application idea.

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M-LEARNING AND TECHNOLOGICAL LITERACY: ANALYZING BENEFITS FOR APPRENTICESHIP

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ABSTRACT

The following study consists on comparative literature review conducted by several researchers and instructional designers; for a wide comprehension of Mobile-Learning (abbreviated *M-Learning*) as an educational platform to provide 'anytime-anywhere' access to interactions and resources on-line, and *Technological Literacy* (TL), as a potential outcome of Technology Education (the study of Technology). The similarity between M-Learning and 'M-Education' might be confusing, in another way, here is explained the difference regarding both. Most of the theory developed on M-Learning was conceived in English, as digital resources of public dominion; however, there is a mention for skills applied by students to use mobile devices, originally conducted in Spanish. The method implemented is deductive/inductive reasoning: Boolean data type. The purpose for this study is to merge it with subsequent investigations, and linking the most outstanding concern with a common dissertation.

KEYWORDS

M-Learning, Technological Literacy, Higher Education, VLE.

1. INTRODUCTION

Meeting the nature of Mobile Learning, in attempt to route its benefits to Technological Literacy, this study proposes to analyze, as much as possible, the origin from which M-Learning emerged; and to understand the relation concerning several concepts involved with this.

For Sharples, Milrad, Arnedillo-Sánchez & Vavoula (2007) research into m-learning is 'how mobility of learners, increased by personal and public technology, can contribute to the process of achieving new knowledge, skills and experience'. Interpreting this, students learn anything at any time at any place although they are not at a fixed or predetermined place. Their learning happens, gaining new knowledge, skills or experience, because they have interested about a specific topic and they will be do anything to get information, interactions with other people, get digital resources or materials about their interests. Also, they have different devices to achieve mediations and virtualizations about their reality and contexts, all of these things are part of informal learning. The students will take advantage of the learning opportunities offered by mobile technologies, but with these learning opportunities, will they achieve learning?

According to the Organization for Economic Co-operation and Development (OECD), there are three forms of learning (as a synonym of education - the multidirectional process whereby knowledge, values, customs and behaviors, are transmitted); this statement of forms departs from the theory conceived by Coombs and Ahmed (1974: 8).

1. *Formal education*: 'highly institutionalized, chronologically graded and hierarchically structured "education system", spanning lower primary school and the upper reaches of the university';
2. *Non-formal education*: 'any organized, systematic, educational activity made outside a framework of formal system to provide selected types of learning to some adults as well as children';
3. *Informal education*: 'lifelong process by which every person acquires and accumulates knowledge, skills, attitudes and insights from daily experiences and exposure to the environment'.

In 1996, the OECD developed strategies for "lifelong learning for all", whose concept of "from cradle to grave" include the three forms of learning. Policy-makers in many OECD countries, and beyond, are therefore trying to develop strategies to use all the skills, knowledge and competences – wherever they come from – individuals may have at a time when countries are striving to reap the benefits of economic growth, global competitiveness and population development.[1]

- *Formal learning is always organized and structured, and has learning objectives*. From the learner's standpoint, it is always intentional: i.e. the learner's explicit aim is to gain develop skills.
- *Informal learning is never organized, has no set objective in terms of learning outcomes and is never intentional from the learner's standpoint*. Often referred as learning by experience or just as experience.
- Mid-way between the first two, *non-formal learning* is the concept on which there is the least consensus, which is not to say that there is consensus on the other two, simply that the wide variety of approaches in this case makes consensus even more difficult.

1.1 The Problem

In this study, there was a lack of a comprehensive framework for implementing m-learning's usability to increase the level of Technological Literacy. In this sense, a process of logical analysis about student's m-learning (i.e. in mobile learning analytics, or MLA). The available theory is inaccurate biased. According to Aljohani & Davis (2012) MLA focuses on: collection, analysis and reporting of data of learners to learn with mobile devices using (interactions between learners, available learning resources, materials and others).

What is the relationship between M-Learning and usability?

What is the main benefit of M-Learning for the Apprenticeship?

Would M-Learning increase the level of Technological Literacy among the Society?

2. SETTING THE CONTEXT

In 2004, the Executive Council into the University of Guadalajara, approved to create a System of Virtual Campus (in Spanish: *Sistema de Universidad Virtual*, or *SUV*) to fit the institution with current necessities of regional society, and in order to improve different formative activities, offering programmes without limits of time/space. Nowadays, the SUV offers formative programmes based on virtual-learning environments (VLE): a baccalaureate, six bachelor-pregraduate, and four postgraduate (3 master, 1 doctoral) degrees. In addition, the SUV gives open courses, providing attention to private sector as much as to the government.

In contrast to that it has been done at the University of Guadalajara, regarding to M-Learning and as a sample of Latin-American research on educational science, at the University of Tartu (as a sample of European research), the studies conducted on M-Learning have been more focused to computational science following the topic "Mobile Web Services"[2]. Actually, the context of such studies is not the Republic of Estonia, but the context of countries from which the researchers came from: Germany, China, etc.[3]

2.1 Review Methods

The purpose of this review paper is to meet part of the nature concerning the concepts *M-Learning* and *Technological Literacy*, and to identify their relation, from a review of literature. The research took place in web-based search engines. The literature search results are introduced in Table 1

Table 1. Overview of literature search performed in August, 2013

Concept	Source		Included	Excluded
	REDALYC Database	GOOGLE Web search	*Meeting criteria*	*Not-meeting criteria*
M-Learning	**12**	**7**	**11**	**8**
Technological Literacy	**1**	**3**	**3**	**1**

[1] OECD: Skills beyond schools. Recognition of Non-formal and Informal Learning | Retrieved 19.09.2013 http://www.oecd.org/education/skills-beyond-school/recognitionofnon-formalandinformallearning-home.htm

[2] http://mc.cs.ut.ee/mcsite/research/mobile-web-services

[3] Mobile Web Services for Collaborative Learning - http://math.ut.ee/~srirama/publications/wmute_06.pdf

Usability reviews will be conducted to establish the relationship between M-Learning and usability.

2.1.1 Search Criteria Details

Web search options: 'language: Spanish, English', 'exact expression: mobile learning, definition' + 'technological literacy, definition' and/or 'm-learning', + 'region: Latin American countries, Europe'

Database options: 'URL: www.redalyc.org', 'language: any', 'type: by keywords=m-learning(8) or mlearning(4)', 'discipline: education' REDALYC gives the reviewer search options by article (proceedings), by author, by journal, by discipline, by institution, and by country of Iberian America (Spain, Portugal, Latin America and Caribe).

Technology Education

Technology Education (TE) is a concept, distinguished from 'educational technology' (Brown and Brown, 2003) and from 'technology in education' (Dieuzeide, 1970). In simple words, TE is the name of a school subject, focused to the students in basic education, or focused to the teachers in higher education.

Educational Technology

The Educational Technology, in another hand, is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources (Januszewski and Molenda, 2008).

Technological Literacy

Gagel (1995; 1997) in Berrett (2001) suggested that technological literacy is as dynamic as the society we live in and that "as long as humans continue to practice technology, what it takes to be considered technologically literate will change" (1995, p. 296). Moreover, Gagel (1997) suggested that *TL* implies the ability to use, manage, understand, and assess technology leading to four generalized competencies: (a) accommodate and cope with rapid and continuous technological change, (b) generate creative and innovative solutions for technological problems, (c) act through technological knowledge both effectively and efficiently, and (d) assess technology and its involvement with human life judiciously.

M-Learning

According to the Standard of Information Security, published by the International Organization for Standardization and by the International Electrotechnical Commission, *Mobile leaning* is a learning platform that provides learners 'anytime-anywhere' access to educational and university resources. "Learners find themselves empowered by using mobile technology to gain access to the required course materials even when they are disconnected from the network." (ISO/IEC 29140-2; in Alrasheedi and Capretz, 2013; p. 1). At the Monterrey Institute of Technology (MIT, or ITESM for its name in Spanish[4]), some studies about Information and Communication Technologies have been made, in attempt to lead alumni to succeed towards a meaningful learning, based on the use of Technology: "since satellite-based models, towards e-learning environments, and more recently, a newer modality for studying was integrated for mobile devices; such modality is known as m-learning (ITESM, 2007a; in Herrera, Lozano and Ramirez, 2008; p. 2).

The lack of 'the single factor of mobility' does not make m-Learning a simple extension of E-learning with an additional feature. The term mobility is not just a feature; it adds several benefits such as self-paced learning, accessibility to learners in remote areas, learning in addition to regular work with immediate application capability etc. (Alrasheedi and Capretz, 2013; p. 3). For instance, Lefoe, Olney, and Wright (2009) identified staff development strategies for using M-Learning technologies in higher education, while discussing how staff members were engaged in using these technologies fox six months prior to introducing them to their students for learning activities within a Faculty of Education; five key strategies to support this learning, were identified: a shared understanding of the theoretical frameworks and philosophies; both an understanding of affordances of the technologies and time to develop skills; participation in authentic tasks; development of a shared language, knowledge and understanding of new pedagogies; and a cycle of reflection. The findings support the notion that a social-constructivist framework provides an exemplary approach for staff development. In another hand, Herrington, Herrington and Mantei (2009) described findings of the project as a whole, and presented principles to inform the design of innovative learning environments employing mobile technologies in higher education learning environments. In a practical sense, *design principles* can refer to characteristics of a planned learning design: what it should look like; or its procedure: how it should be developed (Van den Akker, 1999). Above all they must be expressed in a way

[4] Instituto Tecnológico de Estudios Superiores de Monterrey - www.itesm.edu

that can inform practice (Wang & Hannafin, 2005; in Herrington et al, 2009). Moreover, Marcos, Tamez and Lozano (2009; p. 94) propose the m-learning as an alternative way to foster critical analysis through virtual-asynchronic discussion boards (forums), providing students of ITESM with the ability to process information in a more friendly format than the presented by some virtual learning environments, such as 'blackboard'.

The concept of m-learning refers to teaching and learning processes that occur with the support of mobile widgets, involving mobility of human subjects who can be physically/ geographically far from each other and far from formal educational physical spaces, such as classrooms, training / graduation / qualification rooms or workplaces (Zanela, Reinhard, Schlemmer and Barbosa, 2010).

Finally, Zapata (2012) declared: "it could be said that *m-learning* is actually 'e-learning with less functions' or 'including less-fine features' and more mobility". While this may seem an obvious or irrelevant conceptualization, m-learning presents new, powerful and radical changes in methodology, due to increased opportunities and areas where to perform activities; but mostly by immersing these in a very powerful social context and accepted by the population as a relationship environment (Zapata, 2012).

M-Education

Mobile Education, or M-Education, is the name of a project-oriented approach that will use a wireless virtual community to facilitate the learning activities of its participants; through collaboration in a distributed environment (Farooq, Schafer, Rosson, and Carrol, 2002; p. 7). The objective of the m-Education movement is to increase the level of learning and the access to learning through the use of mobile. It is oriented to basic literacy, language skills, vocational training, or any other type of remote based learning.[5]

Learning Analytics

The 1st International Conference on Learning Analytics and Knowledge (2011) defined Learning Analytics (LA) as the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.

For Lin (2012) the LA focuses on using accumulated learning data through analysis related techniques to provide appropriate information to learners and facilitating learners to adjust their learning strategies (personalization and adaptation) in improving learning effectiveness. Through learning analytics, activities of teaching, learning, and management processes will be significantly changed. Although learning analytics has been considered one of the six critical trends (ebook, mobile learning, augmented reality, game-based learning, natural user interface, and learning analytics) of high education in the near future, there are only few studies focusing on exploring learning analytics related issues.

For Aljohani & Davis (2012) the focus of LA is on the learners and their academic performance, learning process, the main goal of this analysis is to identify the learners who might be struggling academically as early as possible, to allow for implementing some intervention strategies that help such students to succeed.

3. CONCLUSION

The mobile learning is just a part of the evolution of Learning as a whole, during four decades, since the published theory concerning three different forms of learning stated by Coombs and Ahmed (1974).

What is the main benefit of M-Learning for the Apprenticeship? The most substantial benefit from the mobile learning might be a long-lasting acquisition of knowledge, re-transferable by the same way that how such information was acquired as much as those already relevant scholastic activities.

Could M-Learning be helpful for solving problems identified by Technology Education? It is hard to make it, but not impossible. As aforementioned, Fabregat (2012) highlights a negative trend, in a way of how the situation should be taken more seriously to correct preliminary results of implementation.

Would M-Learning increase the level of Technological Literacy among the Society? This question is quite similar to the one exposed by Herrera et al (2008; p. 12): "What skills are needed from alumni to learn through m-learning devices?" Therefore, the answer should be the same for the previous question as follows: "It can be stated that every student requires abilities, capabilities and attitudes such as being self-managed and self-organized, evaluation and selection of information, creativity, communication and collaborative work when studying under a form of learning in motion" (Herrera et al, 2008).

[5] M-Spark - http://m-spark.org/?cat=14

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DESIGNING A SITE TO EMBED AND TO INTERACT WITH WOLFRAM ALPHA WIDGETS IN MATH AND SCIENCES COURSES

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ABSTRACT

This paper reports design and implementation outcomes at middle development advance of an educative program based on use and construction of widgets on Wolfram Alpha platform at higher education level for engineering and sciences areas. Widgets were based on Physics and Mathematics curricula under Project Oriented Learning and Blended Learning methodologies. Widgets constructed by teachers are first used by students to appropriate basic concepts of each course on a mobile learning basis; after, students construct their own widgets applying that concepts but involving different applied situations based on curriculum integration. Two phases of this activity help to develop basic and high level thinking. Description of design combining Wolfram Alpha widget developer, Weebly and Jotform tools to set up the widgets, institutional current advances on teachers training, courses involved and current outcomes of project are presented.

KEYWORDS

Resources, Blended, Design, Mathematics, Sciences.

1. INTRODUCTION

New generations have an increasing expectative about freedom to work, learn and study. Technology has made last expectative easier by establishing an increasing demand of accessible online resources. As educative trends identified with use of technology are related with more successful professional life, there are a higher value in digital abilities, best educative goals and higher demand on adaptative instruction (Johnson, Adams and Haywood, 2011) and technology has an increasing role in education. Every day is more common to include online elements as a planned educative strategy. Terms as blended and hybrid learning has been coined because mobile technology lets to be connected with information, evolving as a media on which education can be delivered to its final recipients. Currently, mobile technologies are main media to access internet (Johnson et al, 2011) while lots of tools for education purposes appears (Edublogs, 2013).

What kind of learning is developed with those tools? Meaningful learning (Ausbel, 1963) is a consolidated term established in modern education when knowledge is growing exponentially and university curricula is continuously diversifying, so students should learn contents whose relationship with themselves, their environment and future requirements is unclear and confuse (Woolfolk et al, 2010). For meaningful learning, any new learning should be based on a prior cognitive structure, to show a deliberate effort to relate it to structures of higher level thinking, to be related with experiences on events or objects, and to include an emotional connection toward prior knowledge and applications. Many authors bring into question meaningful learning (Gaer, 1998; Woessmann, 2001) based on skills for life instead of dense curricula as policy.

2. PROJECT BACKGROUND

Ubiquitous connectivity has generated a large-scale development of applications (Apps) which accompany users all time. With them, each user interacts with its environment. Thus, internet has grown as not official source of learning, so, teachers should be involved with creation of resources using meaningful applications which could improve learning quality and encourage students to apply knowledge in real constructions at same time. In last twenty years, Monterrey Tech has been changing its educative strategies. Ten years ago, Problem Based Learning (PBL) (Polanco, Calderon & Delgado, 2001), Project Oriented Learning (POL) (ITESM, 2007), Curriculum integration and Use of technology (Delgado, 2011) for engineering disciplines (Delgado, 1999) was introduced to improve quality and meaningful learning. Currently, an institutional program for mobile learning seeks to use several technological tools to improve some aspects of education. Tools require to be accessible, easy and useful for each discipline and learning activity, letting an ease implementation by general faculty, not necessarily specialized on them. In this program, use of online tools developed by third parts are been useful to reach last condition. Main intention is that mobile resources should be useful to scaffold learning weaknesses.

A tool which is thoroughly used in math courses is Mathematica (Wolfram, 2013a). Due its syntax, this tool requires a sustained effort of teaching and learning, which remains viable under premises of periodical tracking and a faculty with the same learning orientation. Wolfram Alpha (Wolfram, 2013b) is a recent development with similar characteristics but simpler and more specific; currently free for some of their main applications and including a widget developer with similar structures those included in Mathematica (Educastur 2012). These elements can be displayed on mobile devices when are embedded in applications as Weebly (2013) and their use allows obtain or analyze information. Widgets and their construction could be focused on the domain of knowledge to be shown. iTec initiative (2013) has selected them as a key piece in learning.

Wolfram Alpha widgets let an online mathematical educative interactivity in two ways: a) exploring an abstract concept through interactive visualization developed by a third part (teacher or another student), and b) developing complex thinking when student constructs his own widget carrying out an abstract concept into real visualization. In this project, widgets are included in a didactical purpose where student is encouraged first to discover some aspect of theory and after, to use their knowledge designing new widgets to visualize related concepts. It is the aim of project been considered here whose main lines were depicted by Delgado (2013a) and covering around of 1200 students.

The aim of this paper is describe the final didactic and technologic design for implementation and some qualitative previous results. In the next section, a brief description of project context is stated. After, the tools involved are discussed together with the final structure of activities and basic construction for whole site is shown. Finally, some partial outcomes related with implementation are shown, including teacher training and further recommendations. Paper is closed with conclusions about future implementation.

3. PROJECT ADVANCES: DESIGN AND TRAINING PROGRAM

Mathematics and Physics curricula in Monterrey Tech is ambitious and requires a heavy training by students to appropriate concepts, laws and algorithms taught. Learning is not always based on applications or visualizations, neither the use of it to develop a higher level thinking. Inclusion of growing contents and skills development in mathematics and science courses, together with reduction in effective hours in them has generated weaknesses in concepts comprehension, so students requires more educational elements as support. An educative program based on use of widgets generated properly by teacher will permit a better comprehension through visualization of theoretical concepts in two ways: from application to theory when student uses a widget, and from theory to application when student design and construct own widgets. This two folded intention closes the learning process around a theoretical concept.. Student construction of widgets, through small projects in courses, would allow learning processes at level of analysis and creation in the Bloom taxonomy, which, together with mobility and gamification (Zichermann and Cunningham, 2011) components involved, would work as a strong affective and meaningful learning.

3.1 Technological Elements to Reach Educative Goals

In the first part of each activity, the widget constructed by teacher fulfills two educative goals: a) to identify relevant variables associated with specific abstract concept, and b) to comprehend how an abstract concept is related with an element of reality. This part is accompanied with a questionnaire to generate interaction with the widget. Both elements should appear together to let: 1) interaction, 2) report information and results (text, images), and 3) get a receipt of acknowledgment for student and confirmation of submission for teacher. This integration was solved with Weebly constructing a site with those elements embed. Thus, Wolfram Alpha widget was inmersed in a planned didactical activity. Jotform tool lets to create submission forms of data or files embed in that site, letting to send receipts and alerts of submissions as was desired.

Second part of activity is a complementary practice in widget construction by students, developing high level comprehension based on: a) identifying the full set of variables to visualize an applied problem, and b) integrating the main concept involved with other concepts in related courses. Construction and comprehension are normally inverted: widget construction is possible just if student has used widgets, but construction generates comprenhension benefit with other students (Delgado, 2013a). Description of activity and a form of submission to report the widget externally constructed is provided here (requirement covered with Jotform) and information related with student (author). Figure 1a resume interactions generated in the whole activity: relation with the three tools used in the implementation and delivered products.

3.2 Design of Site and Activities

POL based on use and construction of widgets should involve a set of courses (transversal and sequential) in which integration of concepts would be present, requiring an initial construction of widgets based on critical main topics based on curricular integration. This basic construction will serve as guide to other teachers to extend it to other courses. Final impact expected includes 25 teachers and approximately 1200 students (80% of students in Physics and Mathematics department's courses, a 30% of whole population). First phase will be deployed in January 2014 covering 30% of this statistics, at this time teacher's training course had been offered. Widgets use and development in parallel courses will promote curriculum integration in basic and engineering sciences courses, promoting a better domain of basic concepts. Courses involved and their curricular relations boost curricular integration when a specific widget is constructed (Delgado, 2013a). Figure 1b shows sections of a characteristic activity, as was developed in Weebly, showing general menu of site (Home, Areas and Courses, FAQ blog) and an activity section (Widget, Parts I and II activities with associated submission forms). Jotform lets an integration with external repositories as Box, Dropbox, Google Drive (last was used here).

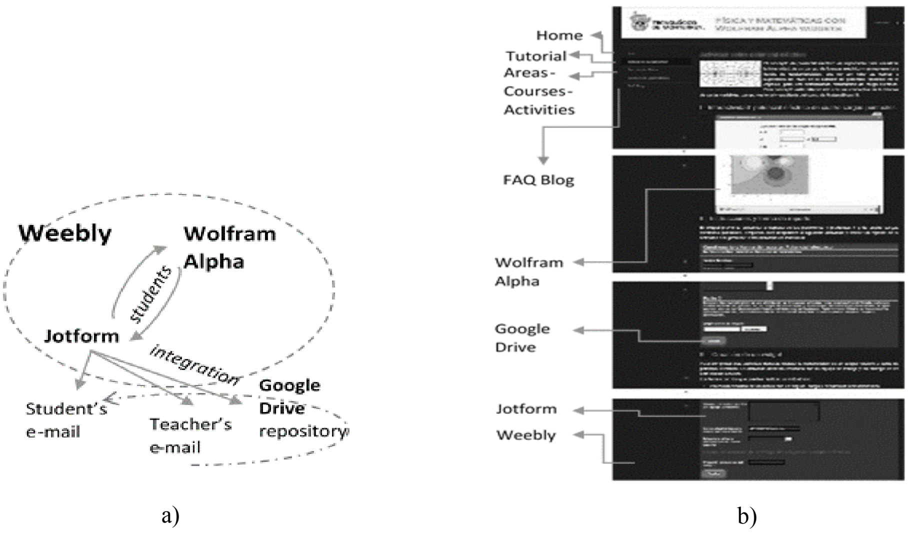

Figure 1. a) Interactions description between student and widgets site through tools inegrated on Weebly; b) characteristic activity sections: Wolfram Alpha widget, widget interaction questionaire (part I) and widget construction specifications (part II). Upper section contains a general menu with support sections of site.

First phase was centered on mobile site construction (Delgado, 2013b) integrating Mathematics III, Electricity and Magnetism, and Differential Equations courses containing: a) Tutorial. b) Analysis activities by widget built by teachers on strategic and representative topics (there, reader can actually review widgets and activities constructed). It includes interactive widget, questions associated to generate interactivity and online report format to send to teacher and includes complementary activities for widgets development by students (based on analysis and concepts comprehension before taught). c) FAQ blog. Didactic guides for each widget were designed grouped in four blocks (in agreement with chronological advancement contents) as proposed brief projects to be developed monthly. Second phase development will include courses as Differential and Integral calculus, Probability and Statistics, Mechanics, Fluids and Thermodynamics.

3.3 Teacher Training

Actually, first phase is complete to start on August 2013. Training program was designed on 70% about the use of Wolfram Alpha Widget Developer and 30% in Weebly and Jotform (last contents is no so relevant because general formats of activities was created being applicable for whole courses with just minor changes. Training includes an extended workshop of following to teachers teams complete defined activities by course. Actually, a central group of teachers, working in phase I, are fully trained. For remaining faculty, training will result in the creation of collegiate mobile sites similar to previous, now for Mathematics I and II, Physics I and II, and Probability and Statistics courses. Last will require design similar sites, organized by a selected teacher as team leader. Training will include following: 1) Wolfram Alpha accounts; 2) Wolfram Alpha widgets construction; 3) Weebly account sharing, cloning and editing current activities; 4) Creating a Jotform account for each course; 5) Jotform basics: sharing, cloning and eding project submission forms; 6) Integrating Jotform with Google Drive; 7) Making a full activity in a selected course.

3.4 Preliminary Insight

Three pilot groups using Wolfram Alpha widgets in Differential Equations, Physics I and Numerical Methods courses were runned in august-november 2013 applying a perception test of students obtaining a qualitative insight about impact on learning. Outstanding positive comments were: 1) visualization lets a better understanding of abstract concepts and connects those concepts with reality, 2) widgets construction extends the range of comprenhension of a concept and it reveals hidden connections with related concepts in other courses. A reiterative improvement suggestion of process was remarked as offering a brief introductory workshop for students about widgets construction is necessary in order to speed up student abilities.

4. CONCLUSIONS AND FUTURE WORK

Mobile educative tools are spreaded for different purposes, so nowadays technology is easily available for teachers to generate learning products. Wolfram Alpha widgets let teachers to show different concepts through visualization and to let students explore and interact with theory and reality. Higher level comprehension is achievable when process is reverted and students generate own widgets related with similar concepts because it requires a deep understanding and analysis about critical variables involved.

Visualization normally goes faraway reaching good level of representation, other related elements should be present because concept being represented will require additional mathematics. Thus, teachers could generate curricular integration adding educative gain in learning, in particularly if it is conducted by the same faculty and collegiate groups because them are able to decide each construction based on selected concepts in parallel courses. Curricular integration is being warranted taking care to emphasize that kind of relationships.

Wolfram Alpha developer has an advantage on Mathematica being relatively easy and programming free. Last means that the whole faculty could generate their own widgets easily. Each student will spend just the time for planning and reflecting about how construct each widget, in order to integrate the different contexts involved in almost just one instruction of Wolfram Alpha, but gathering the several variables and concepts which are relevant to represent each problem. In this sense, time investment should be continuously recovered through periodic activities which let student to deep in course concepts and associated applications. In the past, those constructions were based with more complex tools and programming was involved. Today, there are a lot of compatible tools which can interact in order to develop a more complex educative idea, which in addition is every time more independent from hardware and operative systems in mobile platforms. Such is the case of tools used to solve and to develop interaction requirements stated here: integration, embedding, submitting, stocking up and gathering. Thus, knowledge about tools as Wolfram

Alpha, Weebly, Jotform and Google Drive lets construct a more complex product for educative goals in easy way. This knowledge could boost other educative projects or give to teachers more ideas about further development in same project. Teachers training could be directed to extend the project in other courses because tools involved are so friendly that people could learn them easily. Is remarkable that computer technology has been rapidly developed being this project carry out exclusively by teachers as a collegiate group, where any technological assessment has been provided.

Future work will be based on two aspects: a) to extend the program to the whole courses of Physics and Math department, and b) to include a complete evaluation of educative outcomes by collecting and analyzing students results. A follow-up study should be carried out before and during the initial and global deployment.

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AN ENVIRONMENT FOR MOBILE EXPERIENTIAL LEARNING

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ABSTRACT

In experiential learning courses students acquire new knowledge through learning that takes place in real-life scenarios. By utilizing mobile devices to conduct observations outside of the classroom, learners can arrive at a broader and deeper understanding of their inquiries. In this paper, we propose a learning environment that integrates mobile technology in an overall experiential learning approach. The proposed environment is separated into a host system where information is stored and mobile devices that are directly connected to the host system via applications that allow for ethnographic research and knowledge production. We depict the relevant components and features that are required for an effective implementation of the proposed model. Finally, we introduce a real-world application of the m-learning environment and highlight the benefits of mobile technology in experiential learning settings.

KEYWORDS

Experiential learning, mobile learning environment, ethnography, course design, observation

1. INTRODUCTION

As mobile technology has recently become more widely available, convenient and less expensive, various forms of mobile learning developed into a key trend in educational applications (Petrovic & Brand, 2009; Wu 2012:817). The ubiquitous availability and location-independent usage of mobile devices has made mobile technology particularly interesting for applications in contexts of real-world learning. As opposed to in-class learning, a context-oriented usage of mobile devices allows learners to research and acquire knowledge directly in the field (Petrovic, Kittl & Edegger, 2008).

This way of experiential learning contrasts starkly with modes of cognitive and behaviorist learning theories (Corbett 2005:482). While research on mobile learning has grown significantly in the recent past (Kukulska-Hulme & Traxler, 2007), there has only been little research on how mobile technologies could enhance the specific processes of experiential learning. We suggest that there is enormous potential in applying mobile learning in higher education courses where students are to conduct fieldwork or apply knowledge in real world settings. Thus, a coherent model that integrates mobile and experiential learning into a single framework could aid instructors and learners in applying alternative learning methods.

This paper seeks to address the question of how mobile learning can support learning by experience and observation. After a brief overview about mobile and experiential learning, a generic model for the implementation of mobile technologies in higher education is proposed. The emphasis of the model is on facilitating learning by experience and observation. In chapter three, we demonstrate how the proposed model can be applied in a higher education scenario. Finally, the paper concludes with suggestions for improvement and recommendations for future directions in mobile and experiential learning.

2. MOBILE AND EXPERIENTIAL LEARNING

2.1 Mobile Learning

The proliferation of ICT and its implementation into learning has shown to have significant effects on pedagogical practices (Nachmias, Mioduser, Oren, & Ram, 2000). Mobile technology -- as a subset of ICT -- is likely to play a future key role in learning practices, considering current penetration rates of mobile devices and the growing number of features. Each successive generation of mobile devices has introduced an array of new features such as video and audio recorders, music players, e-mail, Wi-Fi connectivity alongside the numerous applications typically found in mobile apps stores (Wu 2012:817). With a steadily growing number of features and an increased availability of mobile devices, the greatest potential of mobile technology may be found in supporting learning activities that are taking place outside of the classroom. Thus, mobile technologies could become central components of learning environments that focus on learning through experience and observation.

2.2 Experiential Learning

Experiential learning is a holistic learning theory with an emphasis on knowledge creation through direct experience and observation as opposed to cognitive learning theories that emphasize cognition over affect (Kolb 2000). The experiential learning model assumes that "knowledge results from the combination of grasping and transforming experience" (Kolb 1984:41). While *grasping experience* includes Concrete Experience (learning by experiencing) and Abstract Conceptualization (learning by thinking), the two dialectic modes of *transforming experience* comprise Reflective Observation (learning by reflecting) and Active Experimentation (learning by doing). Proponents of experiential learning suggest that learners choose different combinations of these modes in any given learning situation.

Since the first publications on experiential learning (Kolb, 1971; Kolb, Rubin & McIntyre, 1971), the concept has gained much popularity in the discourse of learning theories. Experiential learning has been applied in a variety of scopes, topics and research area: education, management, computer and information science, psychology, medicine, nursing, accounting and law (Kolb 2000). The sheer variety of applications makes experiential learning an interesting starting point to develop mobile learning solutions with an emphasis on learning that takes place in concrete reality.

2.3 Experiential Learning and Observation

In higher education, experiential learning is commonly found in masters, business or research courses, where students frequently work on real world problems. Usually, in these projects students are required to do more than merely reading textbooks and learning for assessments, especially if only little knowledge on a given topic is available. Here, direct observation of real life practices plays a key role in gaining a deeper understanding and acquiring new knowledge.

A workable method for learning through observation may be derived from ethnographic approaches. Albeit ethnographic methods are first and foremost research tools (as opposed to learning tools), their direct "in the field" characteristics seem to be valuable for paedagocial activities. Through ethnographic experiences students develop a profound understanding of their field of study and learn to place knowledge into a meaningful context. As ethnographic methods are usually applied directly in the field, mobile technologies could be effective facilitators in making learners geographically independent. Therefore, a combination of mobile learning technologies with experiential and observational learning approaches could open up new alleys for real world inquiries in higher education.

2.4 Opportunities for Mobile Learning

In this paper, we argue that mobile learning is particularly useful in experiential learning contexts, where learners acquire knowledge through discovery and exploration outside of the classroom. We suggest that a specific set of e-learning and m-learning tools can facilitate and enhance experiential learning processes. The concrete environment and its components are presented in chapter three.

A mobile learning environment that concentrates on the experiential aspects of knowledge acquisition needs to satisfy the key elements of experiential learning and observation as derived from Kolb (2000), NIU (2012) and Wurdinger & Carlson (2010):

- Learning takes place as a result of being personally involved
- Learning takes place in concrete reality
- Learning takes place through experiencing the tangible, felt qualities of the world
- Learning takes place through reflecting on what happened
- Learning takes place in active experimentation
- Learning takes place through challenging real world problems
- Learning takes place through debriefing and discussion
- Learning takes place in a semi-structured environment
- The role of instructors is to facilitate rather than to direct student progress

3. AN ENVIRONMENT FOR MOBILE EXPERIENTIAL LEARNING

In this section, we propose a learning environment with strong focus on experiential learning processes. Figure 1 shows the design of the environment, which is separated into an information system that acts as a host for all types of information and activities, and multiple client systems. While the single host system is typically managed by the instructor, students may utilize their private mobile equipment to capture information.

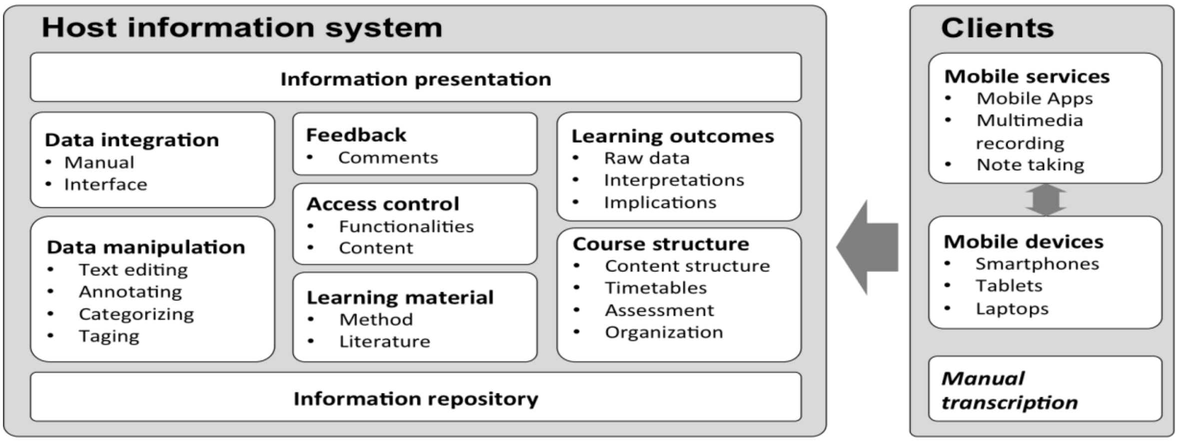

Figure 1. The architecture of an environment for mobile experiential learning

Depending on the structure of the course design, captured information is either automatically imported or manually transferred into the system. The host system may therefore consist of structured and prepared data only, or also include raw and edited material from observations. In the next section, we describe both parts in detail and expand on the design of the environment.

3.1 Host Information System

The host information system builds the foundation for the entire learning environment. The design of the host information system is of significant importance for all activities and therefore for the assessment of a course in terms of motivation and learning outcomes. In this section, we break down the system into its components and describe corresponding functions.

Information repository: The repository holds all types of course-related data, such as field notes, content, findings, presentations, as well as learning materials. It acts as a database and therefore data protection and backup strategies are essential.

Data integration: Data gathered by students are directly stored in the learning environment. The system has to provide mechanism such as input forms for manual data input and data upload. However, the more integrated way to send data to the host is by utilizing mobile services with direct host integration. Specific interfaces allow an automatic import of data collected by mobile devices (e.g. upload learning and research knowledge directly from the field).

Data manipulation: For students it is essential to be able to change or reorganize content at any time. The preparation of raw data for final assessments also requires formatting functionalities for structuring text and media entries. Optionally, image processing and annotation features are useful for multimedia content. The opportunity to categorize and tag content chunks allows a fluent organization of stored information.

Access control: A common learning environment needs to offer opportunities to control data upload and manipulation on a per user or group level. Students must not be permitted to manipulate or access unpublished content of other students. This measure helps to prevent copying from other students as well as deleting content accidentally. Moreover, specific features of the learning environment may be restricted according to the requirements of the course.

Feedback: Similar to in-class courses, an effective e-learning environment needs to offer possibilities to give direct feedback. Commenting functions allow instructors to give comments on assessments and students to give feedback to colleagues.

Learning material: All required learning material provided by instructors should be available directly in the learning environment. This includes material that relates to methodology as well asto key literature. Optionally, information on the usage of the learning environment may be provided.

Learning outcomes: All gained new knowledge during the course should be available at the system at any time. The interpretation of gathered data is an essential step within the knowledge creation process and therefore mandatory. Also implications for various scenarios should be given to demonstrate the applicability of the gained insights.

Course structure: The learning environment is represented according to the structure and organization of the course. The provided learning material as well as newly generated information needs to be structured according to the overall course design. It is crucial that timetables, assessment criteria and other essential administrative information is readily accessible.

Information presentation: Besides the defined functionalities and components, an often-underestimated factor for student motivation is the actual presentation of the learning environment and its content. While many systems largely focus on pedagogical aspects of environments, the representation of information and user experience must not be underestimated. A pleasant design, high system usability and appropriate visualization on mobile devices are key for an efficient learning environment.

3.2 Mobile Clients

While instructors define the host system, students use their own equipment as clients to collect and transfer the data. Thus, clients are entirely managed by students and cannot be accessed or prepared by instructors.

Mobile clients: Students use their preferred devices such as smartphones or tablets to collect data and information. Hardware systems have to match defined minimum criteria in terms of video, photo or audio quality. Depending on the conducted fieldwork, aspects like power consumption or available storage for captured media are to be considered.

Mobile services: A special focus is placed on services for mobile devices. Available software in form of mobile apps specifically designed for fieldwork activities simplifies the process of data collection. Ideally, the host system allows mobile clients to directly integrate mobile captured content into the main system.

Manual transcription: It is crucial to have implemented effective back-up strategies, in case of misuse or system breakdowns. Also, the classic notebook can be used for data collection, transcribing and entering the data manually in the host system after fieldwork has been completed.

4. APPLYING THE ENVIRONMENT IN HIGHER EDUCATION

The general architecture of the proposed environment was realised in a master course in Information Systems in 2013. In our use case, a group of 25 students was divided into five sub-groups of five students each. The central topic of the course was related to customer experience research, where existing innovative business solutions were evaluated. While methods like surveys or interviews rarely suffice to determine real-world customer experience, observation and ethnographic fieldwork have proven more adequate to thoroughly assess customer experience. In this course, five innovate approaches of customer experience were investigated in real world situations.

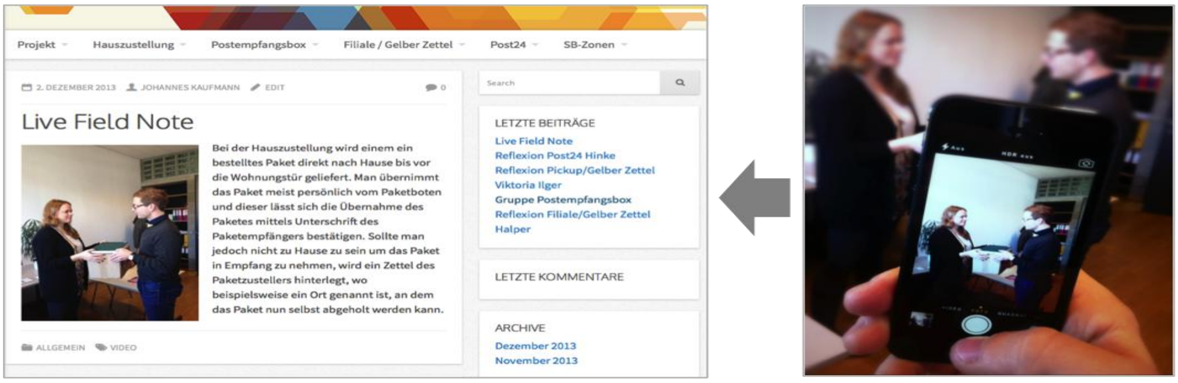

Figure 2. Interaction of host information system and mobile client in an experiential learning environment

The host system for the learning environment was based on the freely available WordPress blog software, which we modified for the specific requirements of the course (see Fig. 2). All pre-required learning materials and organizational information were made available on the system. Categories and menu entries were created for each student group to facilitate navigation throughout the environment. Instructors predefined subpages similar for all groups so each group and student can work within a coherent structure.

The key feature of the learning environment was the direct integration of mobile learning. Here, students used specific ethnographic apps and a native WordPress mobile app to directly post their field materials and learning experiences to the learning environment. Live notes, photos, videos, and audio recordings were uploaded, categorized and tagged to make them available to other students in real time on the platform. For instructors, only posts with specific tags were taken into consideration for assessments.

The feedback of instructors was provided in both, class and online. At the end of the course, students synthesized interpretations for all in-field cases and concluded with implications for future directions regarding the observed customer experiences. In this course, the template engine of the blog allowed us to design both a system with sound usability and an environment that integrated effectively with mobile technologies.

The proposed environment indicates that mobile learning may be particularly useful in experiential learning contexts, where learners gain new knowledge through discovery and exploration outside of the classroom. E-learning and m-learning tools seem to be enablers for experiential learning processes. The application of our m-learning model has demonstrated that a combination of standard software with (native) mobile apps could open up new pathways to facilitate experiential learning that takes places directly in the field.

5. CONCLUSION

Mobile experiential learning is particularly beneficial for students in higher education classes, where learning takes place in real-life situations. By applying already existing knowledge in combination with the gathering of new information through observation, students build and strengthen new knowledge. Especially for teaching in the areas of customer experience or innovation management, observational course designs enrich student outcomes. The proposed mobile learning environment allows the implementation of experiential learning courses with the utilization of students' mobile devices.

The organization in form of a course project implies that learning outcomes occur in a number of different ways. First of all, students learn how to work in teams and get tasks organized within their teams, which is a managerial capability. Second, students learn and practice important methodological approaches. More generally, they learn how to apply a research methodology to produce meaningful in-context knowledge. The collective participation of the entire group of students broadens and deepens the understanding of a specific real-world challenge that students engage with in an experiential learning process.

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SUPPORTING SITUATED LEARNING BASED ON QR CODES WITH ETIQUETAR APP: A PILOT STUDY

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ABSTRACT

EtiquetAR is an authoring tool for supporting the design and enactment of situated learning experiences based on QR tags. Practitioners use etiquetAR for creating, managing and personalizing collections of QR codes with special properties: (1) codes can have more than one link pointing at different multimedia resources, (2) codes can be updated whenever needed without being reprinted and (3) multimedia resources linked through these codes can be commented by any user. This paper presents etiquetAR Mobile App, a mobile application that supports learners' interaction within spaces augmented with etiquetAR codes, offering responsive visualizations of the resources and mobile device adapted functionalities to add contributions. A pilot study with 95 students and 3 teachers illustrates the use of etiquetAR in a real learning activity. The results of this pilot indicate that etiquetAR App facilitates students' interaction with the tags having a positive impact on situated learning.

KEYWORDS

QR codes, Android App, Situated Learning, Pilot Study, Mobile Learning.

1. INTRODUCTION

QR (Quick Response) codes are a type of location-based technology that is attracting a lot of growing research in the field of technology-enhanced learning (Saravani & Clayton, 2009). Among the educational uses of QR codes, and related to this paper, it is worthwhile to highlight their usage to augment physical spaces, such as museums (Ceipidor et al., 2009) or libraries (Walsh, 2011), and in situated learning approaches, where learning is a function of the activity, context and culture (Lave & Wenger, 1990). However, the adoption of QR codes in education is still low and very few tools have been developed for increasing this adoption. Two exceptions are the "QR treasure Hunt Generator"[1] (a web-based tool for automatically generating treasure hunting activities based on QR codes, which contain multiple choice questions defined by the teacher), and etiquetAR[2] (Pérez–Sanagustín, et al., 2013), on which this paper focuses.

EtiquetAR is an authoring tool for supporting the design of adaptive and dynamic situated learning experiences based on "intelligent" QR codes, which extend the interaction possibilities of traditional QR codes. First, etiquetAR QR codes can be linked to more than one resource, allowing the creation of adaptive learning activities, and providing students with information that is more tailored to their profiles (e.g. different grades and languages). Second, etiquetAR QR codes can be updated without printing them again, which enables easily changing the content of the tags, thereby supporting dynamic learning activities. Third, etiquetAR users can add comments to each resource linked through this intelligent QR codes. Unlike the "QR treasure Hunt Generator", which focuses on supporting a particular type of activity, etiquetAR concentrates on supporting the management of QR codes.

[1] http://www.classtools.net/QR/
[2] http://www.etiquetar.com.es

Any QR reader can be used to scan etiquetAR QR codes. However, we detected some technical problems in a real activity carried out during the last academic year at Universidad Carlos III de Madrid (where students used a generic QR code reader for interacting with etiquetAR codes): (1) the web interface where users are redirected when scanning the codes is not appropriate when using a mobile device (the resources are not clearly displayed and users have difficulties writing their comments), and (2) accessing videos or visualizing high quality images is time consuming in places wherein the wireless signal is weak. These technical problems led to some educational limitations: students had difficulties in concentrating, carrying out tasks without interruptions, and in working in groups (from 5 to 7 people) using a single device provided by the teachers. This paper presents a first prototype of the etiquetAR Mobile App, which is aimed at improving the interactions with the tags generated with etiquetAR and at solving the technical problems and overcoming the educational limitations detected in the former edition of the activity. This papers summarizes a pilot study designed to evaluate the use of etiquetAR Mobile App in the second edition of the activity.

2. ETIQUETAR MOBILE APP

EtiquetAR was designed as a web client that allows educators to create, personalize and manage intelligent QR codes, and redirects users to the information stored in these codes when scanning them with a third-party QR reader. etiquetAR was implemented using the Ruby on Rails framework, with a PostgreSQL object-relational database on the backend that manages the collections of QR codes created by the different users. etiquetAR Mobile App is an Android application developed using the Android SDK that interacts with etiquetAR for improving users' interactions with the QR codes generated with this tool (Fig. 1). As shown in Fig. 1, the functionalities in etiquetAR Mobile App can be classified within two groups depending on the moment of the activity in which they are used: Pre Activity (dotted line) or During the activity (solid line).

EtiquetAR Mobile App includes the following functionalities. **(1) "Synchronize"**: to download the contents related to a particular collection of etiquetAR QR codes, storing them in the mobile device. This functionality connects to the web client database to get the information from the collection indicated by the user. **(2) "Read tags and select the content"**: adapts the scanning functionality and the visualization of the resources to be responsive to the screen characteristics of mobile devices. The different contents associated to a QR code are read from the SD card of the mobile device and displayed as clickable buttons. Also, videos can be watched in a full screen mode. **(3) "Comment"**: Adapts the "comment" functionality to the mobile device characteristics so that users can visualize/add comments related to a particular resource in a pop-up window organized by the time comments were created. This functionality also extends the web-based functionality by allowing users to reply to previous comments in a differentiated conversation thread.

The first functionality is the only one that must be always used before the activity and, if possible, in places with a good Internet connection. In this way, if QR codes are updated at the "last minute", the content in the mobile device will be synchronized with the one in the web. Once contents are synchronized, it will not be necessary to have Internet access for reading the content hidden in the tags. The second and third functionalities are always used during the activity. From them, only the "Comment" functionality needs Internet connection. Otherwise, users could not see the comments posted in the tags on *runtime.*

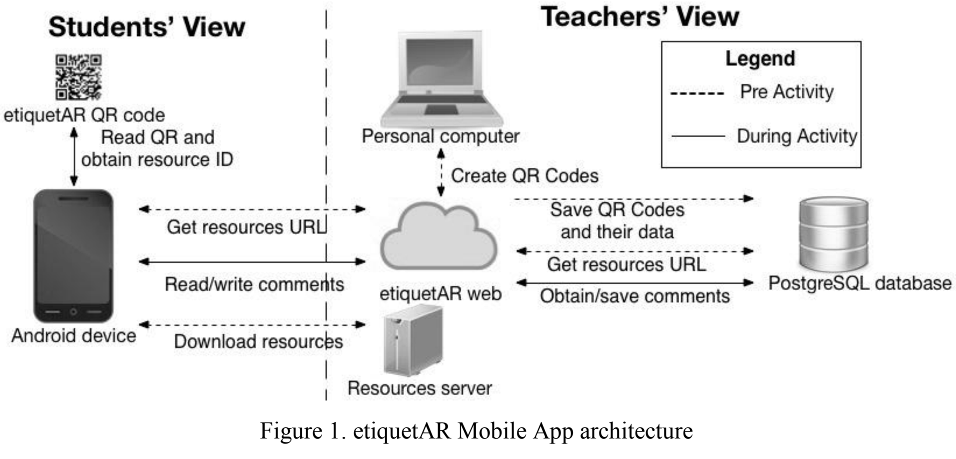

Figure 1. etiquetAR Mobile App architecture

3. PILOT STUDY: DESCRIPTION AND RESULTS

A pilot study was carried out in a laboratory activity of a first year course on System and Fabrication Procedures (SPF) in the studies of Mechanical Engineering at Universidad Carlos III de Madrid during 2013. The objective of this laboratory activity is to show a group of students (95) industrial machines that they would find in their professional career, how they work and which their main parts are. Three lecturers participated in this pilot too.

The three lecturers created 5 etiquetAR QR codes, which were attached to the 5 machines in the lab, for designing a situated collaborative activity. Each QR code contained the following information:

- A video explaining how the machine works in a real production environment;
- A picture highlighting the main elements of the machine;
- A question asking students to reflect on the different ways the machines are used in real contexts.

For the activity, students were grouped in teams of 5 to 6 people. An Assus Tablet with the Android OS and a dossier with problems to solve were handed out to each group (of 4 to 7 people). Each group was assigned to one of the 5 machines before the activity started. The activity was structured as follows:

(1) A **reflection activity.** Students had to scan the QR codes watch the video, see the picture, and answer both the reflection question and the problems in the dossier. This was done for all the machines with 12 minutes per machine. Before answering the reflection question, students could see the answers that their classmates had previously posted, in a way that they could contradict or complement the information;

(2) A **peer-evaluation activity**. After the first phase, students had to return to the first machine. Each team member had to access the tag corresponding to that machine, read the answers to the reflection question posted by their classmates, and evaluate their *correctness* and *completeness* using a Likert scale from 1 (lower mark) to 5 (higher mark).

After the activity, we delivered a questionnaire to the students and interviewed (individually) the teachers. The questionnaire asked students to assess their experience with the etiquetAR Mobile App in a Likert scale [Students Quest]. The results of this questionnaire are summarized in Table 1. Teachers were asked to compare this activity with the former edition, performed with the support of traditional QR readers [Teachers Interview]. Further, two observers took notes during the whole activity, paying special attention to those limitations detected in the former activity (outlined in the Introduction) [Observations].

To have a general view of the results, we analysed the data by following a mixed evaluation approach, in which we combined and triangulated (Creswell, 2003) the results of students' questionnaires (quantitative data) with the observations and interviews (qualitative data). To focus the analysis, we organized it around two questions of interest. We summarize the main results according to these two questions next.

Table 1. Students' ratings in a Likert Scale about the etiquetAR Mobile App. For each of the answers we indicate the number of answers provided and the % over the 95 total answers. We indicate the maximum rates in grey.

	Students' Ratings (Over 95 total answers)				
Question	1	2	3	4	5
Q1. It was easy to read the tags	0 (0%)	1 (1%)	3 (3%)	18 (19%)	73 (77%)
Q2. It was easy to visualize the videos.	0 (0%)	0 (0%)	2 (2%)	32 (34%)	61(64%)
Q3. Videos took lot of time to load	50 (53%)	25 (26%)	7 (7%)	6 (6%)	7 (7%)
Q4. I liked viewing "full screen" videos	0 (0%)	1 (1%)	7 (7%)	28 (29%)	59 (62%)
Q5. It was easy to know who wrote each comment	1 (1%)	8 (8%)	19 (20%)	32 (34%)	35 (37%)
Q6. I wrote lots of replies to my classmates answers	9 (9%)	20 (21%)	37 (39%)	28 (29%)	1 (1%)

(1) Does etiquetAR Mobile App improve the interaction with QR codes generated with etiquetAR compared with traditional QR readers? The results in Table 1 indicate that the etiquetAR Mobile App was useful to interact with intelligent QR codes, facilitating the access to the contents and overcoming the visualization limitations imposed by the mobile device. First, most of the students easily scanned the tags and read their content (77% assess this functionality with 5, Q1), and had no problems visualizing the videos (64%, Q2), even under poor Internet connection conditions (Q3). Second, most of the students rate positively the possibility of viewing full screen videos (62% in Q4). Third, results indicate that 71% of students rated the "comment" functionality positively (71% of rates 4 and 5 in Q5). Observations during the activity indicate that students had no difficulties when answering the reflection question [Observations]. Finally, it is noteworthy that most of the students contributed with comments to the resources and that some of them contributed with more than one comment. This is also supported by the positive rates of students poi when evaluating how they replied to their classmates answers (30% of rating between 4 and 5 and 39% with a rate of 3)

(2) Does these improvements have a positive impact on the students' learning experience? The teachers' interviews as well as the observations indicate that using etiquetAR Mobile App had a positive impact on the students' learning experience. First, teachers stress that etiquetAR Mobile App works better than the generic the QR code reader employed in the former activity, increasing the time students spent on watching the videos and working on the activity. As one of the teachers said "*since this year the application worked better, students had the possibility of watching the videos more than once*" and stressed that with the etiquetAR Mobile App "*students had more time* –to spend on the activity- *and less waiting for the content*" [Teachers Interview, Teacher 1]. In addition, another teacher highlighted that the new App "*gave more time for the students* (for doing the activity), *which was translated into more reflected and better answers* (to the questions)" [Teachers Interview, Teacher 2]. Finally, the observations made during the activity indicate that students spent most of the time discussing about the activities, filling in the questionnaire and reflecting on the different possibilities offered by the machine [Observations].

4. CONCLUSIONS AND FUTURE WORK

This paper has presented a first prototype of the etiquetAR Mobile App, an Android application that targets students, so as to improve their interactions with QR codes generated with the web authoring tool etiquetAR. The results of a pilot study with 95 students and 3 lecturers in a real scenario of situated learning indicate that: (1) the etiquetAR Mobile App provides a more fluid and friendly interaction with QR codes than traditional QR code readers, and (2) this improvement on the interaction with QR codes is translated in an enhanced situated learning activity, in which collaboration among students is better supported, while they focus on the tasks and on the activity performance. Our plan for the future is to add social functionalities to the App, such as a voting mechanism for evaluating the comments, or a system based on badges to reward the best contributions.

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RAISING AWARENESS OF CYBERCRIME - THE USE OF EDUCATION AS A MEANS OF PREVENTION AND PROTECTION

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ABSTRACT

The widespread use of mobile devices that enable Internet access increases the exposure of both individuals and organizations to cybercrime. This article addresses the issue of strategic prevention of cybercrime with the key focus on the measures to prevent cybercrime related to children and teenagers. The primary tool for such prevention is undoubtedly education aimed at establishing greater awareness and knowledge regarding illegal Internet content and cybercrime among children and teenagers, as well as parents and educators. As many children have Smartphones, special attention should be paid to Smartphones and other mobile devices. Awareness-raising can only be achieved with a combined effort of key stakeholders, which we attempt to achieve though interactive educational modules. Therefore, we have prepared blended learning courses aimed at raising the awareness of the stakeholders (i.e. children, teenagers, teachers, and parents) based on theoretical background, practical experience, and an analysis of questionnaires. Face-to-face lectures are combined with courses conducted with LMS system eCampus, which is developed for use on mobile devices and PC computers, thus ensuring extended effects of the developed modules on the level of awareness of children and teenagers, as well as parents and teachers.

KEYWORDS

Cybercrime prevention; information security; blended learning; m-learning

1. INTRODUCTION

The increasing integration of web technologies in everyday life, along with the popularity of social networks and the development of mobile technology, contribute to the creation of an optimal environment for various types of cybercrime and the dissemination of illegal Internet content. Both children and teenagers represent not only the most avid users of new technologies and functionalities, but also the most naïve segment of the population. The general public is also not sufficiently aware of the severity of the problem.

As part of the General Programme on Security and Safeguarding Liberties, the European Commission established the Prevention of and Fight against Crime Programme; the project “Education as a Strategic Method against the Illegal Use of Internet” is funded within the framework of this programme with the key goal of increasing the awareness of the general public, children and teenagers in particular, on the issues related to cybercrime and illegal use of the Internet.

The project addresses the issue of strategic prevention, with emphasis on the fight against cybercrime related to children and teenagers by using education in order to establish greater awareness and increase the knowledge of children and teenagers, as well as parents and educators, regarding illegal Internet content and related activities. Existing initiatives in this field are primarily focused on presenting information in various forms. However, we believe that developing an educational module and actively implementing it in primary schools will contribute to increased awareness of both children and adults. Such a programme will have the following benefits:

- increased level of uncovered illegal content,
- faster and easier work of law enforcement agencies due to greater awareness of cyber victims and increased reporting of incidents,
- decreased number of cybercrime cases due to enhanced information system security.

Awareness-raising in of crucial importance when it comes to cybercrime prevention, and in the field of cybercrime related to children this issue is even more important, since the EU Kids Online survey found that only one-third of 9-16 year olds (33 percent) believed that their parents know more about the Internet than they do (Ólafsson & Livingstone, 2013). Therefore, we believe that all target groups need to substantially improve their knowledge regarding Internet safety and issues of illegal Internet use.

2. CYBERCRIME PREVENTION

In addition to its many benefits, the Internet increases users' exposure to various forms of crime. Indeed, the Internet has given rise to certain criminal offenses that were unimaginable or didn't exist in the past. Levels of privacy have decreased substantially as the Internet-using public's willingness to publish personal information has increased. Once something is posted on the Internet it can never be erased, a fact that the general public, and children and teenagers in particular, easily forget. Furthermore, fraud and scams are designed to take advantage of the virtual environment in which boundaries and time are irrelevant. Young Internet users should be made aware of the threats to their identity and assets, as well as the potential future ramifications of their activities on the Internet. Furthermore, core rules of etiquette in the virtual environment should be communicated to all users (Shea, 1994). Through raising the level of awareness of our children now, we will be moving toward the creation of an information-secure culture in the future.

2.1 Information Security Issues

Information security covers a very broad area. It encompasses both technical security and threats posed by users themselves, whether due to general lack of knowledge or to naivety when exposed to social engineering. In terms of technical security, IT professionals can install firewalls, antivirus software, and enable regular updates of the operation system and antivirus software. However, there is no software to protect the system from its weakest link – the human being. It is possible for parents to select appropriate software that will improve the security on a child's computer or mobile phone. However, it should be noted that mere supervision is not sufficient; a child should be appropriately educated to be aware of the dangers in the virtual environment and should know the basic self-protection techniques.

2.2 Cybercrime and its Impacts on Young People

Children and adolescents represent a vulnerable group of users who spend a lot of time on the web and on social networks. They are exposed to the same threats as adults, but the effect on them can be even more devastating. Due to the seriousness of the consequences, we have focused on the following forms of cybercrime that disproportionately effect young people:

- Cyberbullying – bullying of children and teenagers (threats, harassment, humiliation, embarrassment, etc.) carried out by children and teenagers with the use of the Internet, digital technologies, or mobile phones.
- Online sexual harassment and grooming – includes all actions that aim at lowering the child's inhibitions in order to sexually assault the child.
- Child pornography and the dissemination of inappropriate content – all materials showing children or teenagers in inappropriate sexual contexts[1].

[1] UNICEF estimates that more than four million websites showing juvenile victims, even children younger than two years, can be found on the Internet (Cehovin, 2010). The experience of abuse causes long-term effects on a person's later life, both physical and psychological. The latter includes feeling of guilt or responsibility for the abuse, low self-esteem, feelings of inferiority and depression. With Internet pornography, one must also realize that the child is victimized each time anybody watches material depicting his/her sexual abuse. Due to the ease of disseminating materials on the web and the impossibility of removing material once it is published, it is very difficult to stop the circle of abuse (Dimc & Dobovsek, 2012).

3. PROJECT DESCRIPTION

In order to ensure the use of effective and modern learning methods, we use state-of-the-art LMS application eCampus to create hypermedia e-learning content and deliver it through a blended learning approach to approximately ten percent of Slovenian primary schools. Prior to the development of suitable e-content adapted to specific groups of learners, we performed a preliminary research in order to identify their existing level of knowledge. Furthermore, we also performed extensive theoretical research of the field.

The developed e-courses are interactive, multimedia (i.e. featuring animations, simulations, video), and therefore promote active learning. The interactive modules simulate real life circumstances and, though interaction, the participants actively learn how to appropriately react when faced with cybercrime or illegal internet content.

The developed modules are implemented with a blended-learning method; namely via face-to-face workshops with each of the target groups (children, teenagers, parents, educators), which will be followed by online e-educational activities. Active involvement of the target groups will be promoted also through a competition among schools based on the highest number of active participants that will reach the highest level of knowledge. At the end of the experiment, we will perform a general evaluation of the project and measure the level of knowledge acquired.

The educational modules include information system security, cybercrime victim protection and support, online safety, online activities and communication via mobile technology, etc. As mentioned, we strive to achieve the active involvement of all participants with special attention paid to the youngest target group (third and fourth graders) by designing learning content specifically for their level of understanding and even providing different case studies for boys and girls.

The objectives and methods of the project include:

- overview and analysis of critical areas of cybercrime related to children and teenagers,
- preliminary research which aims to identify the stakeholders' previous knowledge, behaviour in virtual world, and awareness of Internet frauds,
- development of e-learning materials to be included in the educational modules,
- development of blended learning methods (combination of e-learning and face-to-face learning) in order to achieve active involvement of participants,
- implementation of educational modules in selected schools, and,
- evaluation of results.

To achieve these objectives, various expert areas are incorporated in the project: educational, technological, psychological, sociological, and legal. These experts are involved in the project in order to ensure an all-inclusive cohesive content and an interdisciplinary approach. All experts involved in the project have long-standing experience and expertise in their particular field.

Target groups include selected groups from different primary schools: pupils, parents and teachers. The effect of the educational activities will be evaluated through comparison of a questionnaire/exam prior and following the course, coupled with a questionnaire/exam one month after the course that will also be given to a control group. Since the implementation involves ten percent of Slovenian primary schools, critical mass is sufficient to create the multiplier effect and lead to the long-term success of the project.

4. CONCLUSION

Preliminary research displayed a need for additional education regarding the dangers of cybercrime and the importance of information safety for all target groups. In order to successfully address the issue of cybercrime, it is important to implement successful preventive techniques in all target groups. Therefore, we concluded that continuous education plays an important role in raising the awareness of all users and in encouraging them to implement preventive techniques in everyday life. In order to evaluate the effects of the educational module implementation, an evaluation will be performed following the conclusion of each educational module. Through implementation of these educational modules targeting the youngest Internet users, we will be making the first step toward the creation of an information security culture.

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MOBILE GAME FOR LEARNING BACTERIOLOGY

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ABSTRACT

This paper treats serious games. Recently, one of the game genres called serious game has become popular, which has other purposes besides enjoyments like education, training and so on. Especially, learning games of the serious games seem very attractive for the age of video games so that the authors developed a mobile game for learning bacteriology as one of the achievements of their research project. In this paper, the authors introduce the game and show evaluated results about its learning effectiveness.

KEYWORDS

Serious games, Mobile learning, Educational contents, Bacteriology

1. INTRODUCTION

The serious game is one of the game genres, whose name is originally employed by Clark C. Abt, a social scientist, in his literary work “Serious Games” published in 1970 [1]. Generally, serious games mean a certain kind of games that have other purposes besides enjoyments. As written in [2], the digital game is effective for the education and the communication, and then recently, the word “serious game” has become popular gradually because many serious games have been developed and such services have been provided so far, e.g., an education game [3] and rehabilitation games [4-5]. In Japan, a game "Brain Age" of Nintendo DS produced in 2005, whose purpose is to train the brain through the game play, was one of the popular serious games. After that, the word “serious game” has become more and more popular in Japan. As for the academia, several international research conferences on serious games were held in many countries. In this way, the research on serious games has also been becoming significant.

We are interested in serious games for the education, learning or training because we have a certain research project about serious games collaborated with the faculty of medicine of our university and we want to know how such serious games are effective practically for the education or learning in the higher education. Then, we developed one serious game which helps students to learn bacteriology. We also evaluated the effectiveness of the game through the user experiments. In this paper, we show such evaluation results besides introduce our serious game.

2. GAME DEVELOPMENT

2.1 Planning

The planning of a game is one of the important processes for making it enjoyable before actually implementing it. For developing our serious game, a mobile learning game of bacteriology, we made discussions about its design and story for increasing the learning effectiveness besides the enjoyment.

One of the important things in bacteriology is to learn bacterial dyeing methods and suitable treatments for bacterial infection persons. In our game, we decided to focus on the latter one. However, we thought that a simple quiz game is not enough as an enjoyable game. As a game type, we adopted RPG typed game in that a player can reach to the goal of its story by defeating the bacteria as enemies and by selecting some commands to perform suitable treatments. The bacterial shapes and colors were designed to be deformed from real ones in order to attract players as shown in Figure 1 (Left).

Figure 1. Images of game components, illustration of vibrio cholera (Left), contents of the log (Center) and contents of the hint (Right).

A human has the immune strength against external bacteria like the good bacteria and white corpuscles by nature. Then, we adopted the system that these good bacteria actually fight with enemy bacteria, and we choose the command, which is using some antimicrobial drugs or performing symptomatic therapy, as a support. If you use the suitable drug, that damage will become little, but if you use an unsuitable drug, that damage will become much. By using symptomatic therapy command, the good bacteria will recover from the damaged state because that therapy aims at the relief of bad condition. These informations are recorded in the log as shown in Figure 1 (Center) located in the lower part of a screen when the action is taken.

Because it is very difficult for players without any medical knowledge to take adequate actions, we decided to give some hints to a player as shown in Figure 1 (Right) by his/her touching the enemy bacterium twice on a screen. Although a player cannot check some items at the beginning of a game because they are hidden, the player will reveal them by consuming his/her experiment points (EXP) which are gained by the battle during the game. A player can also raise the levels of some parameters that good bacteria have by consuming EXP. EXP is also used for calculating the game score. Once a player meets some bacteria, the information about them will be recorded on "pictorial book" that can be checked later.

2.2 Implementation

We decided to make this serious game as an application of a smart phone or a tablet PC for enabling many people to play the game. However, we also had to decide its platform, i.e., OS because there are several kinds of OS for a smart phone, e.g., Android, iOS, etc. Then, we decided Android as its platform because of the below. Android OS is supported by Google Inc., and that target is a mobile device, such as a smart phone and a tablet PC. Android has ranked as 1st of the share of the smart phone's OS in the world [6]. That share in Japan has also accounted for about 50 percent of all smart phone platforms.

We used Unity for developing our serious game. Unity is a game engine produced by Unity Technologies and it has Integrated Development Environment (IDE). One of the reasons why we adopted it is that it enables to develop multiplatform applications. Using the same source codes of Unity, we can develop a game of not only Android but also iOS. The other reason is that Unity is very easy for everyone to learn how to use.

3. EVALUATION OF GAME

3.1 Evaluation Methods

We evaluated how much our game is effective for the bacteriology study through the following procedures: P1: Pre test, P2:Playing the game, P3: Post test, P4: Questionnaire

The pre and post tests are four multiple choices questions to answer the correct treatment for a bacteria and its patient condition written in a paper. There are eight questions (Test1-1) in the pre test, and there are the same eight questions (Test1-2) and other eight questions (Test2) in the post test. These questions are chosen from the patient conditions appear in the game. We asked subjects to play the game until its end in around 40 minutes. The contents of the questionnaire are the following five questions. Q1 to Q4 are scored by -2 (negative answer) to 2 (positive answer).

Q1. Is the motivation to study bacteriology enhanced after playing the game?
Q2. Are there any feelings that bacteriology could be studied by playing the game?
Q3. Could you play the game in the positive feeling?
Q4. Do you wish to play the game again?
Q5. Please give some comments, e.g., improvement points and unclear aspects about the game.

The subjects are four students who are not medical department students and have not studied bacteriology. Their average age is 23.3 years old. All of them are male. Finally, we checked the difference between the average score of the pre test and that of the post test. We also checked answers of the questionnaire to evaluate the learning effectiveness of the game.

3.2 Evaluation Results

Results of the tests are shown in the left part of Figure 2. In the pre test, the average score, the number of correct answers, of Test1-1 is 2. Since the subjects are students who have not studied bacteriology, their scores of Test1-1 are reasonable. Although one subject has a high score, this seems an accidental score. Contrarily, in the post test, the average scores are 4.5 of Test1-2 and 4 of Test2. As for the variance, in the pre test, the variance of Test1-1 is 3.5. Contrarily, in the post test, the variances are 0.25 of Test1-2 and 0.5 of Test2. From these results, it can be said that our game is effective for bacteriology study.

Results of the questionnaire are shown in the right part of Figure 2. According to the average score of Q1, all of the subjects are not medical department students, so the motivation cannot not increase so much. The result of Q2 shows that almost of the subjects felt that they could learn actually. The results of Q3 and Q4 inform us the subjects could play the game positively and they want to play it again. Finally, the answers of Q5 indicate that it was difficult to memorize the names of bacterium with their patient conditions and treatments together because they were shown illustrations of bacterium. One subject said some of the bacteria illustrations were not suitable for their images.

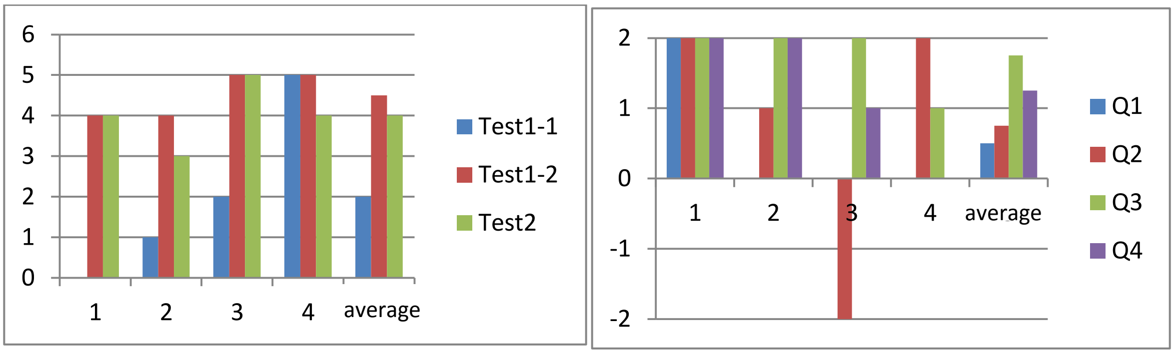

Figure 2. Test results whose vertical axis is the number of correct answers and horizontal axes are subjects and the average score (Left), and questionnaire results whose vertical axis is the score of answers and horizontal axes are subject and the average score (Right).

4. CONCLUDING REMARKS

In this paper, from the experimental results, we clarify that our serious game is effective for bacteriology study. Moreover, the comment says that students without medical knowledge also want to play the game again is caused from the goodness of the game story and the deformed illustrations of bacterium. As for the motivation to study the bacteriology, a good result was not obtained in this experiment. However, it may not mean that our game cannot increase the motivation because the subjects are not medical department students so that they are originally not interested in medicine, and one of them answered that his motivation was increased and there was no subject who answered no. We will verify this point by asking medical department students to play the game in the near future.

Moreover, the problem is revealed that patient conditions and their treatments opt to be linked to illustrations of bacterium instead of their names. Originally, we adopted the deformed illustrations to make it easier for players to remember the characteristics of bacterium but it could not work well. Although bacteria names are stored in the log or the hint, players may not pay their attention to them. Therefore, as one of the improvement points of the game, such information should be constantly displayed on the upper part of a screen. There was indication that bacteria illustrations did not match to the shapes and colors of real bacterium. So, we will improve the illustrations as one of the future work. The number of bacterium appear in the game is 19, and one symptom case is only prepared for each bacteria although desirable treatments are depending on a patient state, such as sex, age, degree, and so on. So, we will prepare more symptom cases of bacterium for the next version of the game. These described above are our future work.

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THE THEORY PAPER: WHAT IS THE FUTURE OF MOBILE LEARNING?

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ABSTRACT

Mobile learning is often described as ubiquitous, pervasive, accessible, and transparent. It has been seen as providing opportunities for those who could not previously cross existing digital divides—though it of course may create new ones. Yet, some work in the field lacks sufficient and appropriate grounding in theory to effectively address such needs. Theory determines what we observe, how we observe it, and what we deem valuable. Theory has power; it can affect how people live and how they view the world. In the case of mobile learning, it can affect how people access and interact with the world. In order to ensure adequate access to knowledge and resources, we must fight against uncritical, clichéd theory and against naïve or tacit theory, and consider the exploration of theoretical perspectives outside the dominant modernist Western-European perspectives and perhaps outside those of late-global capitalism. Research and practice needs to be grounded in well considered theoretical perspectives that take into account the local and the global; the overly represented and the excluded; the global South and the global North. In this paper, we argue for an ongoing and increasingly sensitive role for researchers and theoreticians as well as a reexamination of extant theories in mobile learning.

KEYWORDS

Mobile learning, theory, global North, global South, colonisation, industrialisation.

1. INTRODUCTION

Without wanting to re-enact the definitional skirmishes that have characterised the last thirteen years, there are basically two centres of gravity. The first one is attempting to capture the essence of research, development, and deployment that occurred as a consequence of mobile technologies offering greater and greater opportunities, ideas, and inspirations to the e-learning communities within innovative Anglophone universities of the global North. The second one is grappling with the impact of ubiquitous and pervasive mobile systems on the communities and cultures of the global North and global South[1], mainly the former and certainly not coherently, the impact (and influence) particularly on local and indigenous epistemologies, ideas about what is worth knowing, learning, sharing, teaching and discussing, and how it comes to be known, understood, preserved and replaced, and how mobile systems transform earlier modern notions of epistemology into newer, transient, partial, subjective, post-modern, and post-humanist ones. These could be seen as perspectives that respectively look backwards and look forwards <u>from</u> an era when mobile technology was scarce, obscure, fragile, expensive, and 'other' <u>to</u> an era when mobile technology has become universal, robust, easy, obvious, cheap, and variously described as 'embodied' or 'prosthetic'. As the relationship between human and machine develops (though very differently in different cultures), our questions of the nature of this relationship become more daunting and potentially transformative: whose values and whose perspectives should dominate this relationship?

[1] The global "North" and the global "South" is used to reflect the axis between developing and developed, less-technologised and technologised, rich and poor. These terms are being used to achieve the less pejorative connotations (see Black, 2002). Whilst this can be placed in a more critical framework, it nevertheless ignores the equally compelling East-West dialectic or the resurgence of perspectives from Islamic history and culture.

Theory is increasingly important as learning with mobiles becomes more popular and widespread. Practitioners, managers and policy-makers, and the population as a whole, have become more familiar and confident with increasingly powerful mobile technologies. As learning with mobiles becomes in some senses self-explanatory and self-evident, theorists have dropped out of the picture as ministries, agencies, and corporations invest in learning with mobiles—theory is no longer necessary. In fact, theory still operates in this new configuration, but often it is simplistic, uncritical and tacit in the form of clichés such as ‘keep it simple stupid’ or ‘content is king’. This is difficult when mobile learning research itself is sometimes short on theory: an early review of the mobile learning research literature (Traxler & Kukulska-Hulme, 2006) found many accounts of research projects that were not always based rigorously and robustly on a theoretical underpinning. Further examination of theory is needed in order to determine whether or not Northern theories are useful in diverse Southern contexts and vice-versa. What are the implications of transplanting theory? And, what would be the effects of not experimenting with non-local theories?

2. PROBLEMS WITH THEORY IN THE FIELD OF MOBILE LEARNING

Theory affects what we observe, what we perceive, how we explain what we observe, what we deem valuable, what we deem subject and/or object, and how we connect observations, values, and existing ‘knowledge’ (Neuman (2003). To an extent, theoretical work is akin to ‘sense-making’ (Weick & Sutcliffe, 2005), but through a lens that looks both forward and backward in an effort to both evaluate and rationalise practices and beliefs. Theory in technology may be thought of as “a special form of discourse or expression, specifically designed to hold knowledge, but at the same time, recognise their cultural and human foundations” (Wilson, 1997, 9). But, what does it mean to hold knowledge? And, how are such foundations recognised? Creswell (1998) suggests that theories in the social sciences “provide an explanation, a predication, and a generalisation about how the world operates [either] at the broad philosophical level or at the more concrete substantive level” (p. 84). Post-humanists might suggest “theory today is about coming to terms with unprecedented changes and transformations of the basic unit of reference for what counts as human” (Braidotti, 2013, p. 104).

The theoretical tools we use can shape what we see and what we make. In her work on agential realism, Barad (2007) suggests that the choice of apparatus being used in research determines which properties become determinate and is not solely under the direct control of the researcher. We might add to this idea by suggesting that the properties that become determinate are somewhat *more* under the control of the researcher who is aware of the social, cultural, and philosophical origins and exclusions of the underlying premises. An individual’s view on the meaning of theory is based upon ontological, epistemological, and teleological presuppositions—the acceptability of which is often affected by his/her local, cultural, and geographic positioning. We argue that, in the field of mobile learning, we must become aware of the origins and effects of our theories on praxis: how do our local values affect selection, development, implementation, and the human-culture-machine relationship?

In addition to lack of awareness of our theoretical lenses, there are other possible issues with the use of theory in educational technology: incommensurability of method and theory; lack of depth in reflection; lack of communication between theorists and practitioners, or between theorists of divergent perspectives and differing disciplines; a reliance on jargon and simplified, unclear thinking; and, lack of respect for theory and intellectual work (Wilson, 1997). Braidotti (2013) draws attention to Lyotard’s call for a move away from grand theories towards specific theory; “a position between universalistic pretentions of standing outside space and time on the one hand, and narrow empiricism on the other” (p. 157). What she suggests is a move towards specific theory that is grounded in and accountable to practice, but is also extensible to other uses beyond the local. It is in this extensible space that we might bridge between divergent world-views—between the global North and the global South.

Leading lights in mobile learning have sometimes made arbitrary choices about where they look for ancestors and antecedents. Their choices are often driven by a notion that mobile learning is descended from e-learning. So, the arbitrary choices include psychology, artificial intelligence, cognitive psychology, and educational technology—but often sociology, information systems, and anthropology have been less well represented in the field. The derivation of the theory has, as such, followed on logically to include theorists such as Vygotsky, Pask (1976), Laurillard (2002), and Sharples, Taylor and Vavoula (2005). What is problematic is not related to the valuable work of these scholars, but the lack of inclusion of other scholars from the excluded indigenist, feminist, and/or Southern domains; furthermore the transition of mobile learning from an innovative e-learning programme to an abiding and defining characteristic of most societies places it a long way from its origins. Even more disturbing is the dismissal of theory within the context of capitalist and neo-conservative interests of some of the northerly governments. Braidotti (2013) laments the rejection of theory as unnecessary academic vanity and sees a move within the humanities towards data-mining in research. She suggests that we need to eschew conventional ways of thinking, to deterritorialise theory in the Deleuzian sense (Deleuze and Guattari, 1987). To what extent can we deterritorialise mobile learning? Can we shift away or meld with perspectives outside the more Northerly-centered cognitivist and post-positivist foundations? And, equally important, is this desirable?

3. INDUSTRIALISATION OF HIGHER EDUCATION

Elsewhere (Traxler, 2011) we have developed the proposition that large-scale e-learning is integral to the industrialisation of higher education. It had been conceptualised as such already (Tait, 1993; Illich, 1971; Peters, 1994) and was in part a response to the prevalent political agenda of participation, inclusion and opportunity. We argue that we are at a point where the first generation of industrialised learning has delivered all it can and we see an emergent second generation. Risking oversimplification, the first generation was characterised by inflexible Fordism, the production line; it was driven by the institutions that managed change from the top, from the centre. This first generation emphasised (the lack of) evidence for policy and for the deployment of technology in learning. This is understandable given the evidence-based context, but increasingly, technology became the ubiquitous social norm, digital divides were recognised as complex and counter-intuitive and the role of evidence was changed (or removed).

Manufacturing has become global and ‘just-in-time’. This second generation of learning will be user-driven, or rather consumer/customer-driven, perhaps a neo-liberal nightmare of choice; institutions must respond to the unmanaged pressure from outside that comes from increased ownership, familiarity and expectations around universal personal technologies. Increasingly, technology happens outside institutions, inside which students claim that they are forced to 'power down’. Our questions at this point are to ask whether this represents merely reactions to shifts in the markets of higher education or something more fundamental. Shifts in location of influence are inherently political in affecting social and economic practices (Black, 2002). As universities rely upon mass customization to catch up to corporate practice, adaptation and expectations of local individuals using *universal personal technologies* (in the Deleuzian sense of *becoming machine*) may challenge the corporate powers, these will be situated in radically different cultures and societies and universities compete for global markets.

Previously, technology was ‘other’; it was a dumb conduit, a dumb container for learning; it merely enhanced or supported learning, and it merely serviced the existing order. Now technology is portrayed as socially transformative; technology ‘is us’ (Rettie, 2005). The first generation of e-learning was Web1.0, the web (and the educator) as broadcaster and students were readers; the second generation was Web2.0, everyone as writers and readers. As mobile learning becomes normalized, are technologies reshaping us as entities? Now knowledge is created locally, partially, contingently, for-me, and for-now. Ideologically, social constructivism was the dominant espoused pedagogy of the North, though behaviourism was probably the dominant enacted pedagogy. Education, psychology and computing were the foundations of e-learning, not sociology or information systems. The second generation was expected to develop new ideologies, perhaps connectivism (Siemens, 2005) or navigationism (Brown, 2006) for the 'epistemological revolution' (Des Bordes & Ferdi, 2008). There is however an argument that technology always embodies an ideology, or in this case a pedagogy, and whilst users may appropriate the technology and over-write the ideology, it is certainly not the case that technology is neutral. In fact, we have seen the original MOOC ideology over-written by a more corporate one, and the new ideologies have lost ground and the existing institutions have colonised and co-opted a transformative space. That at least is the rhetoric and ignores the capacity of institutions to appropriate and colonise these new forms and genres. Instead, participative media are being transformed back into the outlets for the corporate message. Our question now is whether what we have portrayed as a second generation of e-learning is merely the tactical reaction of a fundamentally unchanged system to a changing technical and global environment, or whether it represents a local response from outside the system to manifestations of crisis around the system.

4. THEORY AND THE 'SOUTH'

In looking at our analysis of theory, the standpoint of our epistemology is inherently Northern and Western—a perspective that is embedded into technologies and pedagogies. We must address this bias and attempt to frame analysis within a more fluid and complex context. We implicitly assume that the western/European model of universities and their modes of reasoning and theorising are necessarily the sole or best expression of a culture's or a community's higher learning and intellectual enquiry and endeavours. In the days before e-learning, educational interventions in distant and different communities were difficult and thus the danger to indigenous epistemology and theory was remote. Mobile learning now makes these interventions and activities easy, and thus local and marginal, and indigenous forms of understanding and learning are threatened. Education is in many ways a process of acculturation and identity transformation of non-traditional working class and indigenous students in the North and of those in the South. How do we reconcile accessing national educational opportunities and the theoretical biases to exploit these with the preservation of culture and local theory?

5. CONCLUSIONS: FROM NORTH TO SOUTH

In light of this history of distance education and mobile learning, we return to the conventional versus the contingent at the practical level. Theories of 'conventional' e-learning rest on the experience of stable technology platforms; the dominant and enduring nature of operating systems along with their input and output conventions and other computing standards. E-learning 'appears' to take place in a technological environment that is consistent, homogeneous and transparent; the technology (apparatus) no longer gets in the way. Furthermore theorizing about mobile learning—compared to e-learning—is problematised by the fact that mobiles are a massive social and popular phenomenon not a merely minor educational and institutional one, where attitudes, usage and expectations are characterized by appropriation, fragmentation, and transience. Consider emerging concepts such as 'nomadic subjectivity' in which our identities and the perceptions of the devices we use are in constant flux. Such a conception stands outside the terms associated with the conventional technologies built within Northern and western-European theoretical perspectives. To what extent can stable protocols and standards address contingent, ongoing shifts in subjectivity and practice or local/alternative world views? The technology platform upon which mobile learning theory might rest could be, by comparison, volatile, inconsistent and haphazard; otherwise, the work of understanding mobile learning, couched in the terms and practices of conventional technologies, is impeded. We remain frightfully unaware of the connotations of our Western, Eurocentric vocabulary and presuppositions that have muddied the theoretical waters of mobile learning.

Mobile learning needs a 'theory of technology' that is based in its own terminology and to include those perspectives which have been excluded. We could argue that the mobile learning community in looking for theory is—to oversimplify—is faced with three different options and dilemmas: 1) import theory from 'conventional' e-learning and worry about transferability to m-learning; 2) develop theory *ab initio* locally (culturally and economically specific) and worry about validity and generalisability; or 3) subscribe to some much more general and abstract theory and worry about specificity and granularity (applicability to local problems). Although the last thirteen years has brought important advancements, at this juncture we recommend a reexamination of what mobile learning theory is and could be by revisiting the various existing theories of mobile learning. In this paper, we have begun to explore the meaning of theory and its necessity in mobile learning, yet there are still many questions that must be asked. This paper represents an invitation to m-learning theorists and practitioners to explore alternative perspectives in which we include the previously excluded.

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RAPID PROTOTYPING OF MOBILE LEARNING GAMES

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ABSTRACT

This position paper presents the first results of an on-going project, in which we explore rapid prototyping method to efficiently produce digital learning solutions that are commercially viable. In this first phase, rapid game prototyping and an iterative approach was tested as a quick and efficient way to create learning games and to evaluate them by a group of experts. The experiences of the process were positive, as the first prototypes produced were very useful as concrete presentations of the ideas for evaluation. In the next phase, the game prototypes will be tested by teachers and pupils.

KEYWORDS

Augmented reality, education, game design, iterative development, learning games, mobile learning, rapid prototyping, video games

1. INTRODUCTION

Use of both mobile devices and games in education are gradually gaining wider acceptance. Additionally, the recent active discussions of the Bring Your Own Device programs in schools indicates that students using their own mobile devices as learning tools may soon be reality, especially in cases where the schools can't afford to introduce one-to-one programs (Lai et al. 2013). As a first step, elementary schools are likely to adopt small "drill and practice"-types of tasks, in parallel with the traditional educational materials. However, a challenge is how to produce large amounts of games for different kinds of learners, various subjects and age groups, and how to develop pedagogical mobile games cost-efficiently. In general, the mobile games are usually suitable for short term use for a certain student group (drilling). There should be a wide variety of games in order to be able to enrich the traditional learning material and to support differentiated learning (Paavilainen et al., 2010).

This position paper provides the mobile learning community with insights to methods and collaboration networks that can be necessary when aiming to progress from mobile learning game pilot projects into sustainable commercialized applications. In pilot projects the applications can be developed for short-term use by a selected group of people only, and reproduction of the prototype and support of different devices are necessarily not taken into account. However, these usually are the very first challenges that the developers are posed with when working with producers of commercial educational services. In this study, we aim to decrease the gap from the ideas and prototypes to commercial services by a rapid procedure for presenting and evaluating games and by utilizing methods for collaborative development. With the procedure we aim to support the renewal of production processes of existing companies to enable more efficient development of engaging learning experiences provided by mobile technologies. This position paper presents experiences from the first phase of our study, where we have explored rapid prototyping method (Chua et al., 2010) as a tool for young programmers and as a way to quickly produce simple prototypes for evaluation by the stakeholders. In the next phase of the research emphasis will be put on creating processes for the companies for collaborative rapid development of commercially viable learning games.

2. METHODS

2.1 Rapid Game Prototyping

The rapid game prototyping method was utilized in student projects carried out at the Nokia Student Innovation Lab. The Student Innovation Lab is a unit of Nokia Corporation where high school students of Päivölä Mathematics School are offered two year traineeship which they attend in parallel to their upper secondary school studies. Eight students participated in this project during the spring term in 2013. The trainees had some initial programming experience but very little formal training. The platforms used in the implementation have been Windows Phone and web environments.

The challenges of software development projects can be divided into four categories: communication, collaboration, technical, cognition (Begel & Simon, 2008). The rapid prototyping approach takes a stand on each of these challenges. Communication and collaboration are forced by the tight schedule, and under the time pressure, students naturally increase the amount of communication and improve their organization. Having a new technology in use and as the focus of the project helps them to fix simple enough goals. The cognitive challenge is the biggest problem with inexperienced software developers. Young students often fail to identify when to seek help early enough and this has a high cost in motivation.

Rapid game prototyping has been inspired by the Global Game Jam[1] culture. The weekend long game building competitions that online communities started to host about 10 years ago showed the world that a small team can build a working prototype of their game idea within a very limited amount of time. On the other hand, the game design research community also presented highly positive results from testing various methods of iterative paper prototyping.

The target in the rapid game prototyping method utilized in this project is twofold. First, the idea is to use the method to create and initially test game ideas. Working prototypes of the game ideas help in communicating the idea as well as in evaluating the idea. Second target has been a learning process for the students involved in the prototyping. Through the use rapid prototyping method, the students learn to concentrate on the essential aspects of their idea, they learn programming, how to reuse code, get feelings of success and do not have the possibility of falling to the trap of endless polishing of their game.

The rapid prototyping method used at the Student Innovation Lab has been as follows. The work is done in six day cycles. Within the six days the trainees create a game idea, design the initial game and implement a working prototype of the game.

2.2 Iterative Procedure for Developing Learning Games

The steps of the iterative procedure (see Ollila, 2009) used for developing the concepts from the first rough idea or specifications to a refined prototype or even a product are presented in Figure 1. Two essential aspects in the procedure need to be emphasized: evaluation and decision making based on that, and speed of each iteration round.

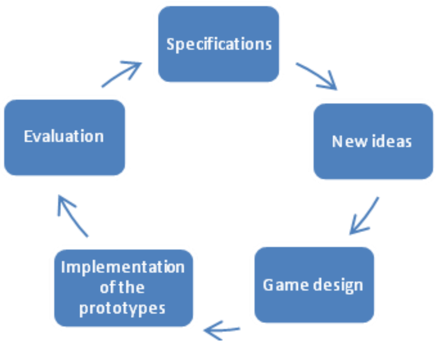

Figure 1. Iterative procedure for developing learning games.

[1] http://globalgamejam.org/

During the spring term 2013, The Student Innovation Lab trainees worked on the project for 15 weeks, two days a week which made it possible to carry out five iteration cycles. Two teams continued to further develop two of the game prototypes during the summer break when the trainees worked full time for a period of six weeks. They implemented altogether 19 game prototypes. Most of the prototypes were implemented for the Windows Phone 8 mobile operating system. Additionally some prototypes were also implemented for running on web browsers on any device running a modern browser. The prototypes were reviewed by the project team consisting of game and user centric design experts and two prototypes were selected to be further developed by the student teams during their summer internship period. Originally the game ideas and prototypes where implemented for mobile phones as basic on-screen games, but at this stage it was decided to test applicability of augmented reality elements with these particular games. VTT's ALVAR library for implementing augmented reality was used and the implementation platform was changed from mobile to PC.

3. RESULTS

The number of prototypes produced during the iteration rounds in this project are presented in Table 1.

Table 1. The number of prototypes produced and evaluated during each development phase.

Development phases	Nbr of prototypes	Evaluators
First ideas by the students	19	Project team (& provider of educational services)
AR game concepts	2	Project team
Refined concepts (company partner)	2	Project team, teachers

During the spring the developed prototypes were evaluated and commented by the project team of experts and some of the prototypes also by an educational services provider. From these evaluations the students received feedback on their ideas and implementations and were given further advice to take into account in the forthcoming prototypes. In the next phase two prototypes were selected to be further developed as the summer projects of the trainees. The selected games were called Laser Game (Figure 2) and Molecule Builder. These two games were selected as they were considered, by the review team, to have interesting potential to be intriguing learning games. Also these two ideas were considered to potentially benefit from adding AR elements into them.

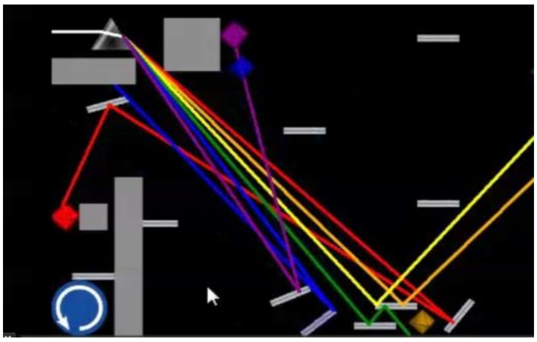

Figure 2. Laser game (the first prototype, no AR-elements)

Laser Game is a game where the player learns some basics of optical physics by directing laser beams to a given goal with the use of optical elements such as mirrors and prisms. Molecule builder is a game for learning organic chemistry. The aim is to repair broken molecules by first collecting needed molecules, then breaking the molecules into elements and finally placing the correct missing elements to the molecule under repair. Augmented reality with 3D-models is used to help the player to understand the 3D-nature of the molecules.

In the next iteration cycle, the prototypes were further refined and taken to user testing by teachers and pupils.

4. DISCUSSION

When starting our project, we identified a clear need for collaborative agile procedures where expertise from various disciplines could be efficiently combined. Creation of partner networks is a central part of the development of work processes. In order to support the adoption of new digital solutions in schools it is feasible to link them with the existing solutions or learning materials, and to build on the learning entities that are familiar for the teachers. We believe that this is a feasible approach for establishing sustainable and extensive mobile learning solutions, instead of small scale applications and pilots.

The first prototypes produced by the Student Innovation Lab were promising and extremely useful as concrete presentations of the ideas for the evaluation by experts. The rapidness of the development was impressive. In the next phase we need to develop the processes for more focused application development, both with regard to pedagogical content and game design. However, even though the process itself was very successful and the trainees were very good at bringing their ideas to prototype level, it seemed that by narrowing the scope of prototyping to a specific area resulted in a decrease in creativity of the development teams. Earlier project, which did not have a similar specified target, ended up with much more creative ideas. So, the question is, did the goal of creating learning games limit the creativity of the teams?

The concepts that were developed in this first phase based mainly on use of the mobile device as a technical tool that is easily available for the learners, in the classroom or elsewhere. However, none of the concepts made use of the mobility of the learners and/or the special features of a smartphone, like e.g. camera, location information or communication features. In the future, these are also features that the students could be guided to utilize in their concepts.

5. CONCLUSIONS AND FUTURE WORK

The rapid game prototyping method proved to be very suitable for quick and efficient prototyping and evaluation of game ideas. Also, for evaluation of game ideas, the different viewpoints coming from provider of educational services, researchers and game designers made it possible to thoroughly discuss the strengths and weaknesses of each idea and how to improve the ideas. When creating new ways for producing learning solutions, procedures that help to create mutual understanding and to visualize the goals are extremely useful. The collaboration between companies and educational institutes, and combining simultaneously students' learning objectives and involving them in a (pre-commercial) co-development project were also regarded as promising initiatives that should be further explored.

Questions that remain for future research are whether the quality of the prototypes or the originality of the ideas improves in the process, as well as how the creativity and motivation of the young trainees will be maintained as more strict specifications are given. In the next phase of the project, the goal will also be to develop more refined prototypes with commercial potential and to determine a more structured process for collaboration between the partners. As more partners will be involved and more specifications will be needed, special attention needs to be paid on efficiency and rapidness of the process, to reach to cost-effectiveness goals.

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PREPARING LESSONS, EXERCISES AND TESTS FOR M-LEARNING OF IT FUNDAMENTALS

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ABSTRACT

This paper represents a result of studying the efficiency of applying mobile learning technologies, as well as the accompanying advanced teaching methods in the area of Information Technologies, at the School of Electrical and Computer Engineering of Applied Studies in Belgrade, Serbia. It contains a brief description of the form of application and distribution of teaching materials designed for the area in question, which are available to students on their mobile devices (Smartphone, iPod touch, Tablet computer...), supplied with the suitable mobile operating systems (Android, iOS, Windows 8…). The paper focuses on the benefits of mobile learning, observed so far, based on the experience of both teachers and students acquired during Information Technologies Fundamentals, a course which is held this year, during which students get familiar with the basic concepts in this area, as well as with its applications which are of relevance for future engineers of computer technologies.

KEYWORDS

m-learning, m-devices, IT course

1. INTRODUCTION

The application of web and mobile learning technologies leads to a "revolution" in education. The world is turning into a global classroom, the conditions for studying are becoming flexible, new forms of application and distribution of teaching materials are being adjusted to students (Brooks-Young 2010). To make them more efficient, new forms of teaching materials are developed on the basis of the available materials, adjusted to the specific conditions. Al these materials are blended for the modern e-materials (Parsons 2011).

Teaching and learning at the School of Electrical and Computer Engineering of Applied Studies (SECEAS) are modernized on constant basis, and adjusted to modern generations of students. Due to the fact that modern mobile devices (m-devices) and programme tools designed for them are becoming increasingly available to teachers and students, the aim of the school is to pay more attention to designing and adjusting the teaching materials for mobile learning (m-learning).

In the first year of their studies in this school, within the programme called New Computer Technologies, students have the course named Information Technologies Fundamentals (ITF). In this course, they get familiar with the basic concepts from information theory and computer technologies, together with the application of information technologies relevant for them. Thus, students get an introduction for the more narrow areas of expertise which they study later at the School. They begin to master the currently used learning technologies, in order to adopt the habit of constant follow-up, examining and using advanced technologies during and after the completion of their studies, and of an active participation in the further development of these technologies after graduation. As of late, all teaching materials and regular knowledge checks within the course ITF have been prepared in a form suitable for the use on m-devices by students in the classroom or out of it. From the beginning of the school year 2013/2014, realizing the teaching and learning in this course includes m-learning, as well.

The coming sections of this paper contain a brief description of: the manner in which these teaching materials have been prepared, the form of m-learning realization and existing experience of both teachers and students with m-learning in this area.

2. PREPARING LESSONS, EXERCISES AND TESTS FOR M-LEARNING

In order to make them more efficient, the teaching materials for the course ITF have been designed based on the generally adopted standards (Lunt 2008) and available literature (Senn 2004, Talbot 2007), just like in any other area. However, the increasing availability of modern m-devices to teachers (in ITF course it is 100% out of all teachers) and students (the survey results in ITF course show 81% out of all students), has conditioned the inclusion of the existing mobile technologies (m-technologies) into the preparation and realization of teaching and learning (Sharples 2002, Georgiev 2004, Trifonova 2006, Anastasios 2009). With the purpose of modernizing teaching and learning in ITF course, a material has been designed which is available on modern m-devices to both: students for learning the lessons, reading instructions for exercises and knowledge self-check, and teachers for providing help in learning and the overview of student progress.

The teaching programme of the course ITF, has been adjusted to the existing standard IEEE/ACM: IT Fundamentals Curriculum 2008 (Lunt 2008). According to this teaching programme, in classroom teaching, students get to learn lessons which comprise the following topics: History of IT, Pervasive Themes in IT, IT and Its Related and Informing Disciplines and Application Domains. During exercises in computer laboratories students master: installing different operating systems currently in use, using programming tools under each of these operating systems, as well as programming tools available on the Internet for creating: documents, block schemes, diagrams, algorithms, wikis and blogs. During exercises students also master team work and communication on the teaching material via the Internet.

The remainder of this section of the paper contains a brief description of the form in which lessons, exercises and tests are prepared and distributed to students m-devices in ITF course.

2.1 Preparing Lessons for m-Learning

ITF course has existed in SECEAS since the school year 2007/ 2008. and it has been modernized several times, through constant consultations with experts in areas of computer science and information technologies. Lessons in this course include the following topics: Information Theory Fundamentals, Managing Information in Computer Systems, Information Transfer in Computer Hardware, Software as an Instruction for Managing Information, Information Management by Operating Systems, Information Systems and Information Transfer via Computer Networks. For several years, SECEAS has had their own site, http://lectio.viser.edu.rs/moodle, on the LMS. LMS Moodle has been elected (Moodle 2.5 Docs 2013), because of: freely software, language localization, simple administration and use and good adjustment to students. For each of the ITF topics, e-lesson has been designed. PowerPoint presentation of the lesson in .pdf format gets its place at the ITF course topic on LMS Moodle, in a specific week of the semester.

2.2 Preparing Exercises for m-Learning

In ITF course, exercises are performed in every week of the semester in the computer laboratory. With the help of assistants, students: have access to Moodle system, install the virtual machine, using programmes under these operating systems, create documents, tables, diagrams, data bases, wikis and blogs, and learn how to work as a team via the Internet. Instructions for work on any exercise in the classroom or out of it, in electronic form, have been designed using Adobe Captivate software which enables creating audio-video material for working on the exercise, with the computer screen for every step of the exercise, and by adding animations and sound. In this way, interactive instructions have been designed for every exercise.

2.3 Preparing Tests for m-Learning

For regular checks and self-checks of knowledge in ITF course, LMS Moodle tests with multiple choice have been designed and placed in the system, each of which covering the content of lessons and exercises which the course includes. Both kinds have been realized in the form of “quiz“ tests, as a part of ITF course testing on the school LMS Moodle system. The questions and answers for all tests have been entered through the system portal into the questions data base, and have been memorized with suitable adjustments (fixed time limit for every question, scoring for every answer, review of correct answers…)

3. LESSONS, EXERCISES, TESTS AND DISCUSSIONS ON M-DEVICES

In order to obtain maximum results, it is always advisable to combine several existing teaching methods (Parsons 2011, Brooks-Young 2010). This chapter contains a brief description of teaching methods that have been elected in the ITF course. In the specific case, teaching and learning are realized inside the classroom and the school computer laboratory in one part, and in the other, out of them. Both kinds however, involve using advanced m-devices, with access to the Internet enabled on them:

- Students have a review of lessons and instructions for exercises in electronic form on their m-devices;
- Regular knowledge checks in the school and self-check outside school, also available via m-devices;
- Students can also access discussions via the Internet using their m-devices.

3.1 Learning from Lessons on Mobile Devices

In each week of the semester, students have a lecture in the classroom. Immediately before the beginning of the lecture, on the web page of the subject called ITF, figure 1, on LMS Moodle school system, they have a PowerPoint presentation of the lecture in .pdf format available to them. They get access to the page in question on the above mentioned system in the beginning of the course. Students can thus have access to the review of the lesson on their m-devices during the lecture as well, and given the huge number of students in the lecture group (about 300), such a review of the lesson can be quite convenient.

Students can access their electronic lesson on their m-devices very easily, through logging in the LMS Moodle system , and regardless of which mobile operating system (m-OS) has been installed on the device (Android, iOS, Windows 8...) repeat reviewing the lesson any number of times, figure 2.

3.2 Exercises Guides on Mobile Devices

During the work on the exercise in the laboratory of the school, as well as after it, on the web page of ITF, on LMS Moodle school system, students can access the link to instructions for the exercise. This instruction is on the school address on YouTube, reserved for this subject, http://www.youtube.com/viserOIT, and it contains audio-video guidelines for working on any exercise step by step.

Students can have access to electronic instructions for the exercises on their m-devices rather easily, through logging in LMS Moodle system, and go through these instructions any number of times, figure 3.

3.3 Regular Self-Checking of Knowledge on Mobile Devices

In every week of the semester students have regular checks of knowledge on the LMS Moodle system, in classes of exercises in the school computer laboratory, during which they can gain points in pre-exam activities. Out of school, students can do self-check tests, figure 4, using their m-devices, also by accessing the LMS Moddle system first. The results of all knowledge self-checks are not visible to teachers, since their purpose is to help students observe their learning progress.

Figure 1. ITF course

Figure 2. Lesson

Figure 3. Exercise guide

Figure 4. Self-check test

3.4 Results of Discussions via the Forums Enabled on Mobile Devices

On regular basis throughout the semester, there are discussion forums on LMS Moodle: via the "news" forums students receive from their teachers all announcements; via the "general" forums students and teachers have e-consultations. Students can access all forums on the course web page (on LMS Moodle system) on their m-devices. Based on the interviews conducted with students, in ITF 2013/2014 course, the following can be concluded: they embrace m-learning of both, lessons and exercises; they accept knowledge checks within m-learning; they accept the role of active participants in the learning process. Based on the interviews conducted with teachers in ITF 2013/2014 course, the following can be concluded: they direct students to m-learning; they encourage students to perform regular self-check; they offer students support and help in learning. The evaluation of m-learning in ITF 2013/2014 course, which is prepared for the end of the course, should provide results on how applying mobile technologies affects the efficiency of IT courses.

4. CONCLUSION

To make teaching as efficient as possible, improve conditions for learning and adjust them to the needs of modern generations of students, the School of Electrical and Computer Engineering of Applied Studies in Belgrade, Serbia, has adopted a trend of applying modern technologies and teaching methods (Talbot 2007). This year, for the first time, the course IT Fundamentals involved the use of mobile devices during lectures and exercises in school, while at the same time, using these devices for learning proves out of school as well. The following factors are considered as important in the development of m- learning;

- Using a suitable system for learning management and constant development of materials in e-form;
- Combining m-learning with other e-learning forms and face-to-face learning;
- Embracing m-learning by students.

Further realization of this course will show in which direction to develop m-learning in it: more intensive cooperation between students and teachers in using web 3.0 tools on the Internet, their joint participation in creating teaching material, as well as in upgrading forms of teaching material suitable for m-learning.

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THE MOTIVATING POWER OF SOCIAL OBLIGATION: AN INVESTIGATION INTO THE PEDAGOGICAL AFFORDANCES OF MOBILE LEARNING INTEGRATED WITH FACEBOOK

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ABSTRACT

We report on the provisional findings of an ongoing research project investigating the pedagogical affordances of mobile learning in combination with Web 2.0 tools for the learning of English for English as a Second Language (ESL) learners. Using Design Based Research (DBR) as an approach to conduct this study, this paper will first present the research that has completed so far, including preliminary results. We developed an initial design framework from the literature and tested and developed this through a series of iterations, each one focusing on particular affordances. The impact of each iteration was evaluated using interviews and qualitative data analysis. One of our findings is the impact of a sense of social obligation whereby participants feel under pressure from their peers to post and to participate. This social obligation effect can have both positive and negative consequences for learning. Our future research will focus on exploring ways in which pedagogical designs for m-learning with social networking can take this social obligation effect into account in order to avoid its negative consequences and make best use of its positive consequences.

KEYWORDS

Mobile learning (m-learning), social network, Web 2.0 tools, Design Based Research, Smart mobile devices

1. INTRODUCTION

The use of Smart mobile technology allows all the tools of Web 2.0 to be accessed anytime and anywhere. As mobile technology can be used to be integrated in teaching and learning process, educators need to understand how they can be effectively used to support various kinds of learning (Kukulska-Hulme, A and Shield, 2008) and develop effective methods and materials for learning. The teachers in the study by (Purcell & Buchanan, 2013:p50) also believe that new technologies should be incorporated into classrooms and schools, as long as they enhance the lesson plan and encourage learning. In this paper we report on a study using DBR to investigate how best to integrate the use of Smart mobile technology (Smart phones and tablets) with web-based social networking (Facebook) in the teaching and learning of English as a second or other language (TESOL) with adult students.

2. RESEARCH AIM

Reporting work in progress, this study aims to find the pedagogical affordances of mobile learning in combination with Web 2.0 tools to enhance teaching and learning and under what circumstances do the affordances work best. Other research questions of the study are to find to what extent can learning through Smartphones and Web 2.0 tools support learner interactivity and collaboration and thus provide pedagogically rich learning environments that engage and motivate learners, and if so, how? How might ESL learners be guided in getting used to the learning of English via tools of web 2.0 and Smartphones? And what are ESL learners' expectations, as they adopt the learning of English via tools of web 2.0 and Smartphones?

3. METHOD

Adopting a DBR methodology, this study involves designing, developing and evaluating a number of educational interventions for students studying English language via Smart mobile devices and Web 2.0 tools. As defined by (Wang & Hannafin, 2005: p6), DBR is "a systematic but flexible methodology aims to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories". It involves designing interventions that are tested, evaluated, refined and adjusted (Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003) These practices reflect DBR's continuous cyclical and iterative characters, which aim to produce design principles, learning theories, interventions of curricular products, instructional tools, and or practical solutions which can be continuously refined and improved. This study is motivated by the conjecture that the language learning experience could be enhanced with the use of Smart mobile devices and Web 2.0 tools, and their integration into a tertiary education curriculum for ESL learners could promote collaborative learning among students. It also tests the conjecture that respondents' uses of the technologies are shaped by the learning activities that they are engaged in and teachers' roles are important to facilitate students' understanding. It is believed that the potentials of handheld learning environment might benefit the portability, social interactivity, connectivity and individuality of ubiquitous devices to connect students to the real and virtual world. As shown in Diagram 1, this study has three main phases. We have completed the Preliminary Phase and are now in the Prototyping Phase.

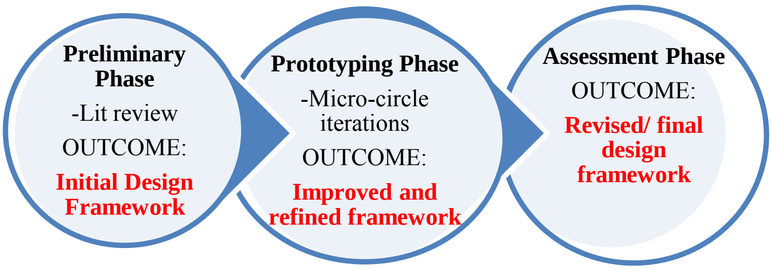

Diagram 1

The Preliminary Phase acted as a theoretical and empirical foundation of the whole study. In this stage, comprehensive review of literature was conducted to clarify the key research terms used in the research, finding the affordances of Web 2.0 and Smart mobile devices for language learning from the literature, and understanding the theoretical principles that underpin most mobile learning projects and relate them to the needs of ESL learners. The outcome for this stage was a development of an initial design framework (Design Framework 1) as shown in Diagram 2 below. Then, we tested and developed the framework through a series of three iterations, each one focussing on particular affordances in the Prototyping Phase, all done in a parallel way. Each iteration, being a micro-cycle of research with formative evaluation as the most important research activity, aimed at improving and refining the interventions to produce Design Framework 2, Design Framework 3 and Design Framework 4.

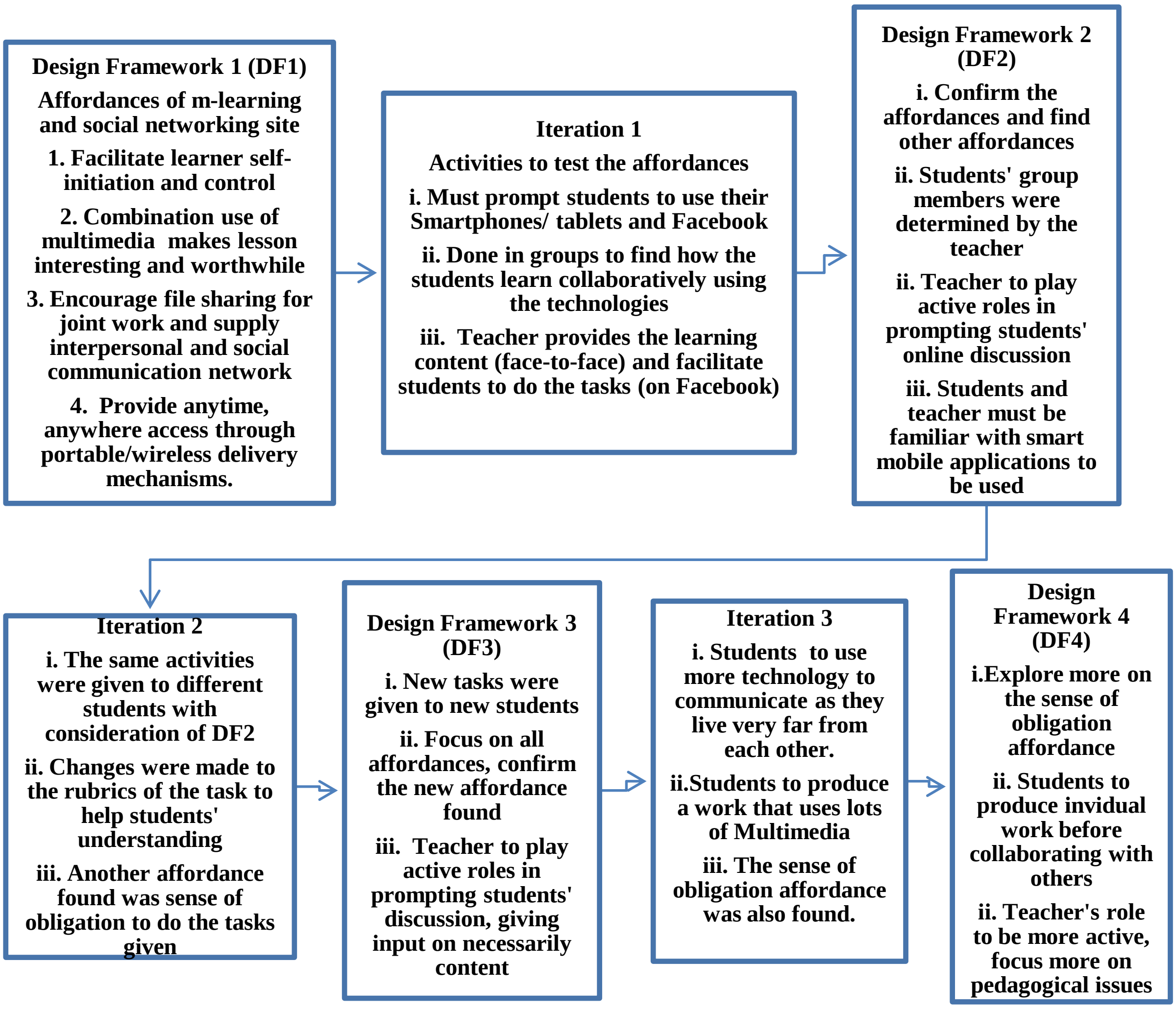

Diagram 2

To test the affordances of Smart mobile devices and Web 2.0 tools for learning in every design framework, all the tasks designed prompted the participants to use the technologies and were done in groups because this study hopes to find how they learn collaboratively using the technologies. The respondents were given tasks that required them to use their Smart mobile devices like Smartphones or tablets and the social networking site, Facebook to search for information, contact their group members to discuss and plan their work and share information for their presentation on their Facebook Group. The outcomes of students' group work were group presentations and video montages. Participants' perceptions of the impact of each intervention were evaluated using semi-structured qualitative interviews (Bryman, 2012). As shown in Diagram 2, three iterations have been conducted so far with three different groups of students participated in each iteration: 6 students participated in iteration 1, 17 students participated in iteration 2, and 7 participated in iteration 3. All of them are Malaysian students studying in University of Exeter, United Kingdom, taking various courses such as Business Studies, Engineering, Physics, and Law. These participants who range between 21 to 28 years old, volunteered to take part in this research. The findings from these interventions will feed into a further iteration to test and refine the resultant design frameworks.

4. FINDINGS AND DISCUSSION

The findings from the three iterations confirm the positive affordances of mobile learning and social networking in enhancing teaching and learning. Generally, all the respondents of this study used their Smartphones and tablets and social networking site, Facebook to do the tasks due to the affordances of the technologies as found in the literature. With the fact that the Smartphones and tablets are their personal belonging, they have a total control of when and where to do the research and discussed about it with their group mates as the devices provide anytime anywhere access through portable/wireless delivery mechanisms. Using various applications found in the gadgets, most produced a very informative, creative and interesting piece of work. Based on our observation and the students' input during the interview, all students were excited to be collaborative in their learning as they could use various kinds of multimedia in their presentations and the video montage. The uses of Facebook Groups were also found to be a suitable platform for students to share their work. The social networking site was found to supply interpersonal and social communication network between students to communicate and also promote their work. Through investigating this combination of m-learning with social networking, we have also discovered a powerful social obligation effect in the combination which needs to be investigated further. Most participants felt the obligation to post work because their work was visible to their peers. Some admitted that they were motivated to respond to the notifications received as soon as possible because they knew that they would not do it later if they procrastinated. Other than that, information finding was found to be something that can be expected from the participants to be done anytime and anywhere using their devices. Some also reported to regret for not buying tablets or advanced Smartphones as they found that other group members produced a better quality of work due to the advancement of software in their smart mobile devices.

As well as motivating, the social obligation effect can also have some negative consequences for learning. Smartphones and tablets may facilitate learner self-initiation and control to do the activities assigned but when they were expected to share their work to a bigger audience, some students were not happy. Postings that are made to Facebook Wall can be seen by anybody on the web if the settings to limit the viewing are not changed. They felt embarrassed to show their work to the public as it might reveal the mistakes that they might have done in their work. They felt pressured as they knew they were competing with other participants whom they felt might be more advanced learners. Other negative aspect of the technologies was when students felt obliged to respond to notifications that were automatically sent to their smart mobile devices. About half of the participants were uncomfortable to receive notifications about the research on their mobile phones as they experienced this as an intrusion into their social space. They reported that they changed their phone setting so that they did not receive any notification about their work on their phone. Nearly all of them admitted that they ignored the notifications because they were in the midst of doing something and there were also a number of them who felt that the notifications sent were too much. Another issue that is related to the negative affordance of the technologies was that since the work can be done anytime and anywhere, nearly all participants also admitted that they completed the work assigned at the last minute. The participants were given two weeks to do the tasks but based on their postings and discussions in their Facebook Groups, most only started to do the work at the end of the second week. This may suggest that some changes need to be done in the next design to avoid participants to produce work at last minute. Probably, the tasks designed should require the students to do them in stages before they are expected to combine and discuss their work in groups. In all the iterations that took place, the teacher created an environment where students were welcome to ask questions and discuss anything to clear any misunderstanding about the task. All the participants admitted that they found the help from the teacher sufficient. However, another negative effect of using m-learning and social networking can be seen when the participants admitted that they felt embarrassed to ask questions in their Facebook Group page. Some felt that their questions might to be too simple to be asked in public. So, rather than sharing their doubts to their groups and also their teacher, most participants chose to ask questions personally to their friends by sending personal messages through their mobile devices. Some also had face-to-face meetings. It is interesting to find in the next the iteration of how these negative aspects of m-learning and social networking can be addressed and how do different technologies and non-technology work seamlessly. Focussing more on pedagogical issues, next iterations will investigate how mobile learning teaching that incorporates the idea of social obligation should be conducted.

5. SIGNIFICANCE

The findings of this study so far suggest the importance of social obligation effect for the design of m-learning with social-networking. The outcomes from iteration 1 to 3 suggests that it is not just mobile learning but it is the integration of mobile learning and web 2.0 tools (Facebook) that leads to the social obligation effect because it involves social network and learning. As this study researches on the pedagogical affordances of mobile learning integrated with Facebook, it hopes to explain the situations where it is not good to use the technologies, when to use it, when not to use it and also how to use it for teachers. The next stage of this study will focus on exploring the motivating power of social obligation in combination with m-learning issue further. Particularly, the design for the next iteration will focus on how teachers should create a motivating and supportive online learning environment, how much notifications are just right and how much is too much and how the activities should be designed to explicitly demonstrate collaborative work among students.

6. CONCLUSION

Overall, the affordances of Smart mobile devices and Web 2.0 tools which were tested in this study confirm the conjecture on the abilities of these technologies to enhance collaborative learning of English among ESL learners. However, respondents' uses of the technologies are shaped by the learning activities that they are engaged in and this study found that teachers' roles are important to facilitate students' understanding. The findings from the iterations in this study also revealed that the integration of mobile learning and Web 2.0 tools has an effect of giving obligation to its users to respond to notifications of message that are sent to their mobile devices which can be both positive and negative for engagement and learning. The next iteration of this ongoing design-based research explores how to make the social obligation effect of combining m-learning with social networking positive for learning and how to avoid its potential negative consequences.

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WHEN EVERYONE IS A PROBE, EVERYONE IS A LEARNER

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ABSTRACT

Most students globally have mobile devices and the Global Students Laboratory (GlobalLab) project is integrating mobility into learning. First launched in 1991, GlobalLab builds a community of learners engaged in collaborative, distributed investigations. Long relying on stationary desktop computers, or students inputting their observations by hand into web-forms, GlobalLab today is pioneering the use of mobile devices as sensors to collect and stream data to the shared database where students can use visualization tools to see data on a world map, analyze the information, identify patterns and trends, and extract meaning from aggregated data. Moreover, this paradigm can enable the practice of crowd-sourced student-scientist partnerships where students stream locally-captured time- and location-stamped data for use by scientists in their endeavors, getting in return feedback, advice, and much needed motivation for learning.

KEYWORDS

Inquiry, mobile learning, probes, sensors, telecollaborative, visualizations, crowdsourcing

1. INTRODUCTION

There are 1.1 billion students in the world according to the United Nations (Primary education). It is reasonable to project that 80 percent of them have or will have mobile devices like smartphones and tablets (Portio Research).

These mobile devices have built-in sensors that either record the environment or respond to changes in the environment. These include still and video cameras, sound, ambient light, proximity and magnetic field sensors, accelerometers, and gyroscopes. Mobile devices also have built-in GPS functionality to precisely determine locations. Moreover, there is a growing trend to add additional functionality to mobile devices (Mobile Device Insight, 2011).

GlobalLab leverages the popularity and functionality of mobile devices to empower their users to be data gatherers and submitters and deploy data analytics in their learning. In GlobalLab, everyone is a probe, able to collect data about the world around them and submit their findings for sharing, analysis, and discovery. Users can create data streams that are time and location stamped and submit them directly to the GlobalLab server in real-time. There, the data are shared and visualized for data processing and analysis. Data streams are displayed on global maps and can be graphed, charted, and compared by range, latitude, and longitude. Data gathering and visualization becomes a collaborative global endeavor. Teachers can implement data collected in real time by the geographically distributed community into their daily instructions.

2. BODY OF PAPER

GlobalLab, which has been piloted in nearly 30 countries, offers a new learning paradigm called telecollaborative inquiry (Berenfeld, 1994). GlobalLab harnesses social networking, cloud computing, and new technologies to engage learners in distributed, hands-on investigations that uniquely build content mastery and foundational skills (Yazijian, 1998). The current GlobalLab reflects its past and future scope and it leverages twenty years of evolving computer technologies and pedagogical strategies that, when integrated, afford entirely new ways of inquiry learning.

Inquiry focuses students on constructing their own knowledge through investigative projects. In GlobalLab, learning is "telecollaborative" because Internet connectivity changes the nature of inquiries, multiplying the power of individual inquiries (Berenfeld, 1994). Telecollaborative inquiry enables students to leverage their community's findings to make the data more meaningful and learning deeper, more immediate, and more efficient (Means, 1998). Students conduct one experiment or collect one set of measurements, but in return they then have everyone's data to study. In addition, immersing students in a distributed community of learners better deploys the social aspect of learning: students feel needed and valued as they begin to appreciate the importance of their data to the entire community (Berenfeld, 1999a).

Telecollaborative inquiry also teaches the processes of science. When a teacher tells students to make measurements in a specific location following a strict protocol, students can conclude that these instructions are arbitrary and irrelevant. But when they understand that many other classes are making the same measurements and they will then compare their findings, the need for rigorous protocols and common standards becomes almost intuitive. Students also can begin to grasp that the essence of science is collaborative knowledge construction. Telecollaborative communities of inquiry, for example, provide a critical audience and rationale for peer review (Berenfeld, 1999b).

2.1 Launching Telecollaborative Inquiry

First launched in 1991, the GlobalLab project was an eight-year effort supported by several grants from the US National Science Foundation that explored the use of the Internet for engaging students in authentic, collaborative scientific investigations. The project culminated in the first yearlong, middle-school, interdisciplinary science curriculum that implemented online collaborations for student inquiries. The curriculum used the Internet, affordable tools, and scaffolding to link teachers, students, and scientists into an international community united by common goals, curriculum, and technologies and engaged in real-world, open-ended investigations. Nearly six hundred schools in almost 30 countries on five continents participated in the project (Berenfeld, 1994; Berenfeld & Bannasch, 1996).

GlobalLab was one of the first classroom communities of practice to deploy a curricular structure and community-building techniques. Students communicated with their peers worldwide, engaged in building their own community, and learned both science skills and content. Rather than individual classes trying to understand natural phenomena using a single set of locally collected data, GlobalLab classes examined datasets from the entire community, accelerating and deepening students' understanding of key science concepts. This model of telecollaborative inquiry delivered on the promise of Internet connectivity to enhance education and justify the enormous costs of wiring classrooms for computers (Berenfeld, 1999b).

Structurally and metaphorically, GlobalLab was organized as an international, networked, science laboratory with every participating class having its own presence. All interactions between schools were computer-based, and each school was a fully functional node on the network. The community was supported by a virtual library where project data and background resources were kept, a project-wide electronic bulletin board for announcements, and online discussion groups for students and teachers. Student forums allowed classes to post their findings, ideas for further investigations, and research plans. In their own online discussions groups, teachers reflected upon their practices and shared tips and advice (Berenfeld, 1999b).

Learning in GlobalLab is an almost Hegelian dialectic of similarities and dissimilarities (Berenfeld, 1994) that exemplifies the pedagogical value of distributed, telecollaborative inquiry. GlobalLab emphasized uniformity; students used the same tools and strict protocols at the same time to collect data on their study sites. This uniformity enabled them to study their local environments in precisely the same way, thus allowing for comparisons and analyses. Yet, while sharing common methodologies, the GlobalLab community was geographically, ecologically, and culturally diverse, and represented many unique social and historical perspectives. When students, therefore, placed their findings into regional, national, and global contexts, they inevitably discovered that their data differed from each other (Yazijian, 1998).

When students explored the causes of these differences, the interplay of uniformity and diversity yielded a dynamic and stimulating learning environment. Students learned about statistical variations, the reproducibility of data, and metadata. They experienced how science operates, which, by its nature, is collaborative. And as they sought to account for the differences in their data, they learned to separate facts from inferences, and how some phenomena must be reproduced by distributed peers.

2.2 Similarities & Dissimilarities

The duality of similarities and differences in data offered learning opportunities that sometimes impacted students' lives. A GlobalLab class in San Antonio that was part of a research cluster studying CO_2 levels, for example, determined that its classroom had relatively high levels of CO_2. Its students assumed that the CO_2 had caused observed classroom respiratory illnesses, but the science advisor assigned by the Project to the cluster helped students understand that a correlation does not necessarily mean causality. Through a productive online discourse students hypothesised that the real cause of the increase in respiratory illnesses they surveyed in the classes with high CO_2 levels was inadequate ventilation in the classroom.

Pressured by the students, the school's administrators called in environmental professionals to take their own CO_2 measurements. Indeed, their findings correlated to the data that the students obtained using the project's tools and protocols. For these GlobalLab students, it was, in the words of their teacher, "a moment of glory" (Berenfeld, 1993). In a reflection of how science is generally taught in secondary schools, the same teacher, in a personal communication, noted that her students assumed science was just memorizing content from textbooks and they eagerly engaged in GlobalLab activities to avoid doing what they had perceived as "*real science*" (Linda Maston, personal communication).

When performed by a single classroom, hands-on science inquiries deliver limited experiences. But when performed simultaneously by a hundred networked schools, they provide a rich set of data that can be the source of many interesting discoveries and conclusions. GlobalLab demonstrated that distributed, synchronized investigations in virtual communities offer more powerful learning opportunities than small or individual inquiries.

GlobalLab's innovations were effective and widely praised by teachers and the education community. Based on surveys, classroom observations, and teacher and student interviews, GlobalLab enabled student inquiry. Students demonstrated increased abilities to design, execute, and interpret experiments. Network-based peer review was particularly effective. Learners enhanced their abilities to evaluate experimental design and benefit from criticism. They better appreciated science and ethics, and became more aware of their accountability to their peers. Significantly, they also acquired science process skills like the abilities to articulate research problems, create procedures, and analyze data. Teachers also reported that the project motivated at-risk students and other typically under-served groups. In all participating classes, students' attitude towards science improved and their curiosity of world problems related to science appeared to increase (Primary education; Means, 1998).

Thanks to these accomplishments, GlobalLab was featured in *Science* (Holden, 1993), *Wired* (Leslie, 1993), and *Fortune* (Corcoran, 1993) magazines, and National Public Radio. The White House's National Information Infrastructure 1994 Agenda for Action report cited GlobalLab as an exemplar of online K–12 education in America (The National Information Infrastructure, 1994).

2.3 Unleashing the Power of Students' Creativity

GlobalLab today (www.globallab.org) has evolved into an integrated, web-based learning platform that supports collaborative investigations, crowdsourcing, and authoring of investigation-driven learning modules.

Its technologies include:

- virtual research environments
- data enrichment technologies
- data exchanges, aggregation, and visualization
- data collection directly from probes via the Internet
- a sophisticated, cloud-based authoring system that allows users to create investigations and surveys.

Users can generate tables for collecting qualitative data and streaming data from probes. They can visualize all data in charts and tables as well as geographically on maps.

The GlobalLab platform's intuitive authoring system provides pedagogical scaffolding for students willing to propose their own projects and invite collaborators from the international community. The platform has been developed based on a novel paradigm that encompasses cloud-based data processing, project-based learning, crowdsourcing, ICT instrumentation, IT solutions, as well as modern pedagogical approaches. It allows for challenging, unique, and engaging research projects that, in turn, open the door to more comprehensive endeavors. At the same time, GlobalLab projects help users to choose their future vocations and prepare them for successful career opportunities. All GlobalLab projects comply with national educational standards. Students, for example, can directly upload data from a wide range of inexpensive, commercially-available digital probes, streamlining data collection and enabling real-time graphing and visualizations of phenomena. Such a capability further reinforces the project's portal and web-based tools as an entire ecosystem for learning and teaching.

One of the developers' primary objectives was to structure GlobalLab's platform so teachers could use it in the core of their daily instruction. The pedagogy of telecollaborative inquiry conflicts with the structure of science classrooms, which tend to be insular, textbook-centered, and demand definitive answers in accordance with course scheduling. Typical science classrooms function with daily granularity; each class is predictable with its activities and outcomes, a characteristic that true collaborative investigations often fail to produce. As a result, inquiry projects too often remain as ancillary instruction to mainstream science classes, used after school or with motivated students.

To bring collaborative inquiry into the heart of classroom instructions, GlobalLab adapted its model of open-ended investigations to the realities of classroom practices. The project offered a new framework that functioned at the granularity of daily instruction, addressing teachers' needs to present designated content areas and build specific science process skills. Key to this effort was the delivery of the digitized content that integrates collaborative data acquisition, sharing and analysis. There have been widespread efforts to adopt digital textbooks to avoid the costs of print textbooks and ensure students always work with up-to-date information. GlobalLab now enhances the effort by adding real world inquiries as a series of sequential investigations called projects. Each project provides necessary content and instruction to ensure just-in-time availability of learning resources necessary for collaborative investigations.

2.4 From Stationary to Mobile Learning

More significantly, GlobalLab is leveraging the routine availability of mobile devices among students. It is developing a series of probes that run on smartphones, tablets, and laptops, enabling users, for example to monitor sound levels with microphones of their handheld devices (see Figure 1); and others in development will measure light intensity, the strength of the magnetic field, wind speed, distance, acceleration, temperature, barometric pressure, and humidity. The latter three can transform a mobile device into a handheld weather station.

Figure 1. Sound levels measured with the use of mobile probes together with a photograph made on location, are streamed to GlobalLab data base. Geo-stamped and color–coded the data are represented on a regional map.

Enabling mobile devices to serve as sensors is hardly unique to GlobalLab, however. What is unique is the aggregation and real time visualization of collaboratively gathered datasets, making data visualization a critical component of collaborative, inquiry-based science learning (Berenfeld & Barstow, 1996). There are only limited learning opportunities when a single class measures local noise levels. Single datasets offer limited possibilities without baselines and comparisons becoming often just a lot of numbers.

GlobalLab, on the other hand, enables users to stream locally captured data in real-time directly from their mobile devices to the GlobalLab database where data from many classes are aggregated A class collects one set of data and receives hundreds in return. Moreover, all data are time- and geo-stamped, enabling each dataset to be placed on a world map by both location and time (see Figure 1). Learners then can use the database's tools to visualize the data in charts and graphs, enabling to discern patterns, trends, and meaning.

2.5 Crowdsourcing for Authentic Science

This tight integration of mobility to learning also offers opportunities for citizen/scientist partnerships. When data is automatically submitted to databases with time and location stamps, scientific crowdsourcing can become a reality. Scientists no longer have to worry if data were collected improperly or if a user submitted incorrect coordinates. Moreover, a mobile device's most important sensor—its camera—provides a measure of groundtruthing.

For example, the GlobalLab paradigm can enable a ground-level UV monitoring network in which users collect and submit UV data with their mobile devices. Scientists now use computer models that account for solar radiation and cloud cover as seen by satellites. Citizen-scientists can submit UV data along with light intensity readings to account for cloud cover. Moreover, they can forward images of the cloud cover to confirm the data's veracity.

GlobalLab will continue to pioneer the use of mobility to foster true inquiry-based learning both in and out of the classroom. It will allow teachers to integrate student-generated data into the very fabric of classroom work and allow scientists to integrate citizen-generated data into scientific endeavors. When everyone is a probe, everyone will be a lifelong learner.

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MOBILE LEARNING AND ART MUSEUMS: A CASE STUDY OF A NEW ART INTERPRETATION APPROACH FOR VISITOR ENGAGEMENT THROUGH MOBILE MEDIA

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ABSTRACT

Nowadays Mobile technologies in Museums and especially in Art Museums are a popular way of communication with their audiences. These kinds of technologies have a high communicative potential and also could be a tool for marketing, information, engagement and learning as well. However with regards how these resources explain the meaning of works of art, generally they maintain the same language of the traditional and passive resources like texts, labels or brochures, especially when the involved audience is general public. This means that Art interpretation is still based on formal description. On the contrary, Mobile Media provide new opportunities of interaction with audiences; the visitors could visit a Museum from their couch; or even they could create content about a painting through their mobile devices. Therefore, if the media of communication with the audiences of Art Museums are changing, there must be a change of how art is explained.

Accordingly, this paper examines a case study developed in a wider research about Art interpretation and Mobile Media in which a new message to explain Art is explored. This new Art interpretation approach combines the contributions of Cognitive Phycology about Art perception and the possibilities of interaction of Mobile and digital technologies. The case study has been conducted in a local museum whose collection consists mostly of sculptures and paintings from the Nineteenth and the Twenty centuries, especially Catalan Art from this period. A blog called "A small exhibition of Deu Museum", tablets and QR codes were used for the development of the fieldwork. However, according to the conceptual framework of the research, the most important thing is the content that is behind the QR codes. Also the preliminary results are exposed in this paper.

KEYWORDS

Art Museums, Interpretation, Cognitive Psychology, General Public, Mobile learning.

1. INTRODUCTION

Art museums represent traditionally the category less permeable to the introduction of museological innovations. Across the second half of the Twentieth century, museums of science or history changed the way they presented their content by creating interactive learning resources to decode the meaning of their collections to visitors. However, still in the early decades of the century, Art museums museology continues to develop largely an academic museology where the most important element is still the work of art and its contemplation. The curators of Art museums have rejected interactive resources in the exhibition, especially in the Mediterranean context due to the museology conception and its purposes (Gomez Martínez, 2006). This strong rejection in introducing interactive museology was justified with statements that Art museums could became an amusement place and that the existence of an interactive resource was an obstacle to contemplation of art (Prats, 2004). These reasons are the result of the traditional conception of Art museums as a "temple" unwavering and the work of art as an object almost sacred. In any case, Art museums only have introduced some innovations in two fields, namely the development of interesting educational programs addressed to specific minority audiences and the introduction of portable electronic devices such as the audio guides. In short, they are resources or activities supporting passive experience of the visit, nothing related to interactive and collaborative strategies.

However, the high degree of market penetration of Mobile technologies like Smartphones and Tablets, as well as the development of collaborative strategies due to the Web 2.0 and other digital resources provide Art museums a new way of intermediation to develop engagement elements through these channels and then bring their content in a perspective alternative to the passive contemplation of the work (Parry, 2010). Shortly, this technological development opens the doors to create a new form of communication between Museums and its visitors. In fact, the new resources that can be developed by these technologies do not create a physical barrier between the art work and the viewer. They can be used within museums but in a more subtle mode. Also these resources allow connecting with new audiences, such as young or adult Smartphone users. These kinds of audiences consider these means a closer form of dialogue with "the great temple of the Muses" as always Art museums were considered. This aspect does not prevent Art museums from continuing to develop an academic museology within their rooms, on the contrary it takes benefits from the opportunities offered by mobile technology resources to start talking through the same Media of the users who visit their rooms, access their web page or downloaded the application.

Also, it is remarkable that the most downloaded App of museums in 2011 was the Louvre Museum[1] and the first application for Smartphone launched was the Brooklyn Museum of Art in the U.S and in Europe the Vatican Museums, both dedicated to art[2]. Last year the sixty per cent of the 10 most downloaded applications corresponded to museums and cultural heritage and museums art, mostly of them were Apps of Art museums[3]. Furthermore, the development of different resources based on Mobile Media for Art museums is in continuous progress, the presence of Art Museums in Social Media such as facebook or twitter is increasing; very often Art Museum develops Mobile Application; or they develop innovative projects as the last editions of the project *Veo arte por todas partes* called #Tagging Museums[4].

2. CASE STUDY

2.1 The Theoretical Framework of the Case Study

Even the innovations on the use of technological resources for Art Museums and the opportunities of these media for speaking to new audiences or new ones, the “languages” used to engage audiences is not different to the language of the traditional labels or the exhibitions texts[5]. The passive resources deployed in Art exhibitions are characterized by an academic language based on the formal description of the works of art, written from the perspective of the curator, art historian or art expert. Consequently this language is not close to the knowledge about art of general public in Art Museums.

For that reason, this approach proposes to explore a new strategy for Art interpretation based on the distinguished Art feature, emotions that it provokes when is looked at. This aspect is which differ Art of others disciplines like History or Sciences. One of the most common reactions in front of a painting of any kind of person, especially, not art experts is to express whether it is liked or not. Accordingly, why do not engage visitors in Art Museums using resources based on emotional mechanisms of art perception?

Traditionally, there has been a lack of interest for the emotional aspects that art provokes on the viewer from the perspective of Art History and also from the perspective of Art Education in Museums. However, Cognitive Psychology from the sixties of the twenty century started to build a theory about Art perception in which emotions have an important role. The contributions of authors as Gombrich (1950, 1960), Goodman (1968), Gardner (1982, 1990) and Csikszentmihalyi (1990) have been the base for the theory of Art perception, even now, is in an early stage of development. Therefore, the theoretical framework of this case study have been elaborated by the theories of these authors and others about Art perception, as well as the more recent investigations about Mobile learning as learning theory implemented in informal educational contexts (Sharples, Taylor, &Vavoula, 2010), (Kress & Pachler, 2007), (Traxler, 2009), to deploy and evaluate an alternative way for Art interpretation in museums using Mobile Media.

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[1] http://www.appolicious.com/education/apps/102549-musee-du-louvre-musee-du-louvre (Accessed December 2013)
[2] http://mediamusea.com/2012/01/25/primeras-apps-museos/ (Accessed December 2013)
[3] http://www.brighthub.com/mobile/iphone/articles/117634.aspx (Accessed December 2013)
[4] http://www.veo-arte.com/ (Accessed November 2013)
[5] In the research which this Case Study comes from, an analysis of more than fifty Art Museum Mobile App has been developed. It demonstrates the language and resources of these media maintain an academic description of the art whose purpose is just to give information about the collection, the museum or the cultural events of the institution.

2.2 Museum Setting: Museu Deu

The research project was carried out in *Museu Deu* located at El Vendrell (Tarragona). The institution is a public museum but the collection comes from a private collector of the town who donated his collection to the local government in 1987. The museum was inaugurated in 1995 in a historical house called "Palau Rabassó". The art collection of the museum is composed mostly by sculptures and paintings from the nineteenth and twenty centuries, especially Catalan painting from the second half of the Nineteenth century until the early avant-gardes. The exhibition starts on the second floor, the collection of paintings is displayed in chronological order. The most representative painters of the whole exhibition are Joaquim Mir, Ramon Casas and Ramon Sunyer belonging to Spanish Modernism and also Josep Mompou and Ramón Calsina, representatives from the Catalan avant-gardes (Payan, 2008).

This Museum shares the features of local museums in Spain. This means lack of departmental structure, small staff, low budgets and heterogeneity of a discrete number of users. In the case of *Museu Deu*, it has three permanent staff workers covering the administrative, educational and cultural activities, design and installation of exhibitions and administrative management. This museum offers stably educational activities especially aimed at school groups, temporal exhibitions and a small dynamic center of cultural activities for the city. Related to the number of visitors, the Museum registers around 10.000 visitors per year. The most part of the visitor are school students and tourists, especially elderly people.

2.3 Development of the Case Study

The activity developed for the research, titled "*Visit Deu Museum with Mobile Media",* is based on the use of Mobile devices such as Smartphones and Tablets, as well as digital resources: QR codes and a blog called "*A small exhibition of Deu Museum*"[6]. In the exhibition rooms the twelve paintings selected have two QR codes, a black code and a red one. The content of each code forwards the interpretation of the paintings located on the blog. The black codes hold the academic interpretation of the work of art while the red codes hold an alternative interpretation of the art based on the emotional mechanisms of art perception. The visitors are able to use the Tablets of the Museum or their personal Smartphones with QR code App. Each visitor should use only one of the colours of the codes during the visit because the aim of the research is to evaluate the visit experience depending on the type of code used during the visit.

As it has been mentioned above the majority of the visitors of *Museu Deu* belongs to school students and groups of elderly people, however the target public of the research is general public. Consequently, it has been necessary to select control groups belonging to general public. For that, two collectives of visitors were used, one of them; adult members of social and cultural associations of El Vendrell and the other one; undergraduate students from the School of Education of the University of Barcelona. Therefore, before the visit, the activity and how tablets and QR codes App is used within the Museum are explained. During the visit, there was a person to resolve any kind of technical problems or doubts. Finally, after the visit the users have to fill an on-line survey as a method to evaluate the satisfaction of the visit experience. Also, to conclude the visit the users have been asked about their feedback of the activity. Since the level of the comments provided by the users was very informal, the feedback was not included as a research tool of the study. However, it was very helpful to collect the users' comments for understanding the benefits and disadvantages of the project.

2.4 Discussion

The visitor satisfaction survey has been structured in four sections according to the variables considered for the research: knowledge about art, level of use of Mobile devices, visit experience and sociological profile. The results of the survey have been quantified and statistics techniques have been applied to analysis the results of the survey. Due to the characteristics of the study, the most appropriated statistics technique is the analysis of variance, (ANOVA) to analyze the differences between groups.

[6] The URL of the blog is: http://museudeu.blogspot.com.es/ (Accessed December 2013)

The preliminary results show that the level of satisfaction is higher when the knowledge about art and the level of use of Mobile devices is higher, whereas the satisfaction lowers when the knowledge about art or the level of use of Mobile devices is poorer. However, according to the purposes of the research the most important aspect is that regardless of the knowledge about art or the level of use of Mobile devices the level of users' satisfaction is higher when they carry out the activity using the red QR codes, which contains the alternative interpretation of the art based on the emotional mechanisms of art perception. Therefore, the preliminary outcomes of the research demonstrate that the use of emotions for art interpretation produce a higher level of engagement among general public in this case study.

Consequently, although the technological development of the research is not highly innovative according to the current possibilities of digital and Mobile Media in Museums, the most important contribution of this study is the use of Mobile Media for a new approach for Art interpretation strategies in Museums and its impact on visitor engagement. In that sense, this approach uses the digital and Mobile Media as a means and not as an end, but taking benefit of the positive aspects of these Media.

3. CONCLUSION

The preliminary results of the case study show some important advantages of this approach about Art interpretation. Firstly, according to the outcomes the most important aspect for engagement in museums is the message, more than the media because with the same media the visitor satisfaction is higher using the alternative way for art interpretation. Secondly, after the development of the case study, we assert that the use of Mobile media provides irreplaceable tools to explore deeper the engagement possibilities of this kind of Art interpretation resources. Finally, this case study demonstrates the high possibilities of the Art interpretation based on the emotions that it can provoke for visitor engagement.

Obviously during the development of the case study we could observe some limitations of the activity related mostly to the technical issues such as the difficulties of use of the tablets for some kind of visitors or connectivity problems. Also, another limitation is the language, the activity has been design just in Catalan, although the data collect has finished, the activity will be translate to Spanish and English in the next months.

To conclude, although the limitations mentioned, we consider that this case study could open de door to a new way of Art interpretation in Museums addressed not only to the art experts, but a wider public, using a new message and also a new media, the mobile media, which is already the current and future media of communication and even the media of learning.

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LEARNER CENTRIC IN M-LEARNING: INTEGRATION OF SECURITY, DEPENDABILITY AND TRUST

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ABSTRACT

The paper focus on learner centric attributes in a m - learning environment encounters the security measurements. In order to build up a systematic threat and countermeasure for protecting the learners as well as providing awareness and satisfaction in utilizing the mobile learning system, a security model need to be overhauled. The brief literature survey is conducted and analyst to produce a new classification and definition. The paper introduces new definition, concepts and classification model integrating security and dependability for a learner centric security model and evaluation to assess the confidence and satisfaction level of learners.

KEYWORDS

Leaner Centric, Security, Dependability, Trust, Satisfaction.

1. INTRODUCTION

In today's emerging mobile world that are widely accepted by people in the use of many kinds of applications, presence of vulnerabilities, threats, faults, failure and error is unavoidable and the information technology application, devices and models will never be entirely secure. Security dependability and trust need a mechanism for the changing and evolving environment issues and should be able to resist future unpredictable threats (Savola 2009).Without adequate protection towards the devices, networks and applications, services and personal data, trust will slowly vanish out from the user perception in mobile systems.(Basili et al. 2004) mentioned that The International Federation for Information Processing Working Group 10.4 defines dependability as trustworthiness of a computing system which allows confidence and trust to be justifiably placed on the service delivers. Security will have to be ensured from end to end point which is from application layer right up to the physical layer. Traditionally there are two different communities separately working on the issues of dependability and security. One is the community of dependability that is more concerned with non malicious faults(Buja & R.Menis 2006; Avizienis et al. 2001; Birolini 2004; Laprie & Roche 1995; JC Laprie 1992), to name one of just a few. The other is the security community that is more concerned with malicious attacks or faults (Molisz 2004; Medhi & Tipper 2000).

Integrating the security and dependability in a trusted environment introduces a new classification in security, especially a new platform to mobile learning scheme and mobile learners. It gives a reliable platform to user to adopt m-learning in a secure environment and introduces awareness to the learners as well as help the higher learning strategic plan team to understand the security constraints involved in implementing m-learning in the future.

2. THEORITICAL JUSTIFICATION AND RELATED WORKS

Dependability was first introduced as a generic term encompassing concept such as reliability, availability, maintainability and safety as well as related measures. (A, Laprie, B, & C, 2004; Avizienis et al., 2001; Buja & R.Menis, 2006; Laprie & Roche, 1995; J.C.Laprie, 1995; Neogy, 2010;Meadows, 1995; Meadows & McLean, 1999; Zhang, Chuang, & Kong, 2009; Dhama et al., 2009) presented two alternative definitions for dependability as the first one is “the ability to deliver service that can be justifiably trusted” and secondly “ability to avoid service failures that are more frequent and more severe than is acceptable”. A more rigorous definition and classification of dependability can be found from(Jonsson 1998);(Jonsson et al. 1999);(E. Jonsson, 2006a);(Jameel et al. 2005).However (Trivedi et al. 2009)several dependability classification exist but not all are useful to quantitatively access the attributes which some still need qualitative measures and access the attributes of variety of system networks as mentioned is the previous study. (Savola 2009) inputs for mobile devices are still not well defined , incorrect, and cannot be accepted as harmless because mobile devices are still defective and dependability of the system is becoming more and more critical.Security in a traditional definition refers to actions taken to protect data against unauthorized disclosure, alteration and destruction.(Erland Jonsson, 1998;Catherine Meadows, 1995; C. Meadows & McLean, 1999) presented an outline of a fault model for security and showed how it could be applied to both fault tolerance and fault forecasting in computer security. Security researchers consider confidentiality, integrity, and availability and sometimes, non-repudiation or authenticity to represent the security status of the system and networks but it is lack of representing reliability and performance (Trivedi et al. 2009). (JC Laprie 1992) described the extended attributes that are relevant to security such as robustness, accountability, authenticity and non repudiation. There is a huge database of theoretical work that focuses on different security related properties and different type of information security models (R. Savola, 2007; Daniels, 1989; C.Wang, 1997; K. Zhang, 1997; McLean, 1990; McCullough, 1998) and continuous effort to new approaches on security which has started from dependability approach and continued with security techniques. The security of mobile communications has, and will continue to be, a core issue of high practical relevance and therefore an adequate protection to devices, networks, applications, services and personal data are needed because the trust and confidence in mobile systems would quickly vanish, as has been the case with so many Internet-based services (Savola 2009).In the near future (Yang & Peterson 2004) the concept of trust will become more essential since it is a complex concept with many different attributes relies within it such as dependability, truthfulness, security and etc. In the emerging wireless and future mobile technologies and communications they need to differentiate between trust, security and dependability concepts and the relationship is in demand.The trustworthiness of a computing system which allows reliance to be justifiably placed on the service it delivers (E.Jonsson, 1993;JC Laprie, 1992;Kyriakopoulos et al., 2009;Erland Jonsson et al., 1999).It is suggested as an extension of dependability in (Dobson et al. 1990)by giving judgment on the accepted ability of the system rather than being a property of the system. (Hu et al. 2011)explained that the concept of trustworthiness is appropriate for large and complex systems with ambiguous or inconsistent. According to (Savola 2009), user trust and actual trustworthiness of the mobile solutions need to be balanced since the user population of mobile devices and services is growing, both in the consumer market and in professional use. Furthermore trust should always be obtained, measured and accessed in order to preserve the user’s confidence that she or he can keep the service under control and that the service will not misuse their personal data or information. More rigorous work done by (Jameel et al. 2005)proposed a model for evaluating trust based on vectors of trust beside basic factors of trust computation.

Studies argued for the need of integration of dependability and security and it is important to have a cross discipline task to establish generic, widely and unambiguous trust model (Savola 2009).Brief description of the system model for security and dependability attributes originally proposed in (Erland Jonsson, 1998 ;Erland Jonsson, Strömberg, & Lindskog, 1999 ;E. Jonsson, 2006b)from the standpoint of behavioral and preventive terms. (Avizienis et al. 2001)defined and summarized fundamental concepts of dependability. They presented the pathology of a failure and they compared the definitions of three widely known concepts: dependability, survivability, and trustworthiness. The classical definition of dependability encompasses the attributes of reliability, availability, safety, integrity, and maintainability. The classical definition of a security encompasses the attributes of confidentiality, integrity, non-repudiation, and availability. (Nicol et al. 2004)presented measures of dependability and security and reviewed model representation/analysis techniques. (Sallhammar 2007)proposed an approach to integrate security and dependability evaluation based on stochastic models.Other integrative approaches to security and dependability are found in (Laprie & Roche, 1995; Hu et al., 2011; Trivedi et al., 2009; R. Savola, 2007 ;Sallhammar, 2007; Catherine Meadows, 1995; C. Meadows & McLean, 1999; Nicol et al., 2004 (Sun et al. 2010) (Hu et al. 2011) (Serpanos & Henkel 2008) (Spanoudakis 2008) (JC Laprie 1992) (Jameel et al. 2005) (E.Jonsson 1993) Erland Jonsson & Laleh Pirzadeh, 2011) as well as in the results of MAFTIA project (Project IST Research 2003)and SecurIST project (Project IST Research 2003).

3. NEW DEFINITION, CONCEPT AND CLASSIFICATION

At the user level point of view availability is therefore best regarded as a separate attribute reflecting whether or not the system can deliver its services. At the same time to possibly accept a low reliable system that must be available as system failures can be remedied quickly and does not involve the delivery time However on this model availability is chosen to be the appropriate methods at user level because reliability ensures availability and if the system is reliable that means the system is able to detect repair or tolerant fault and run in a secured and secure state. Reliability will be the transparent attribute of availability; reliability works at the system level and availability works at the user level. This availability attributes represents the learners and non learners behavioral attributes of dependability. ***Dependability Behavioral Attribute (Availability):*** *The ability of the system to be connected easily and links are available at a minimum pre specified level of usage with system remain operable and maintain performance in the event of one or more specified threat.*

Accessibility is generalized under the hierarchy if information system which gives an importance to the user's experience. This could be much related to the m-learning environment as learners from various locations with a variety of devices need to access to the system without failure. To extend these concern accessibility is strongly related to user level terminology of m learning system. Furthermore accessibility attributes is used in this model because in (Zeta Dooly, Jim Clarke, W. Fitzgerald, W. Donnelly, WIT; Michel Riguidel, ENST; Keith Howker 2007) project reports a mechanism and tool are needed for accessing and proving the level of security and dependability of ubiquitous environment which substitutable to m-learning system. The security level applied to the mobile will impact the accessibility of the systems. ***Security Protective Attribute (Accessibility):*** *Ensure the mobile learning system and data are highly accessible at all times, preventing denial of service attacks with maintaining authenticity to authorized learners and disclosure data and system in trust environment.*

Users need to know that service is existence, know the ways they can contact and access the services (EL-Kiki & Lawrence, 2006). On the user perspective quality of a service is much closer related to awareness which refers to degree of goodness and usefulness of the services given by the system. Mobile learners need to get convenience, expediency and immediacy of mobile learning in appropriate time and accessing the appropriate learning contents (K.S, Daniel Su, 2006). Address here that if a learner are aware of usability of the mobile system, it means the extent to which m-learning system can be used by the specified users to achieve their learning goal with efficiency, satisfaction and acceptance to use the content of the system. Awareness guidelines empower the effort in creating highly acceptable and trust to use the system which promotes learners satisfaction while learning via mobile and ensemble devices. ***Security Behavioral Attribute (Awareness):*** *Knowledge and attitude of learners in m-learning system regarding the protection of ensemble mobile devices with secure behavior by understanding potential threats.*

As suggested here is a learners' environment integrated with security and dependability interrelates with trust, as dependability is a subjective and reflects the learners's degree of trust towards the m-learning system. The learner's environment illustrates the interaction between learners and well established, trusted system domain knowledge. *Mobile Learners are classified into a secure domain holding the attribute of awareness, accessibility and availability which give a complete trust towards using the m-learning system via their ensemble mobile device.* Therefore, it is clearly stated that personalization in a mobile learning environment to be introduced representing qualitative judgment of learners security assessment via factors that involved with user or learners direct contact to trust. This study considers availability, accessibility and awareness as security attributes for mobile learners in mobile learning. Precedent studies showed that the trust played an important role in the security, satisfaction of learners in mobile learning acceptance as a formal learning tool. The Learner Centric Security Model developed in this study integrates theories of security and dependability. Briefly the model composed of three aspects; (i) Learner & Device (ii) Security & Dependability and (iii) Trust & Satisfaction. These three aspects combine to develop a description of m-learning at user level. The criteria for the evaluation instruments were based upon this description. Figure 1 illustrates the new classification of dependability and security integration at learners level trustworthy

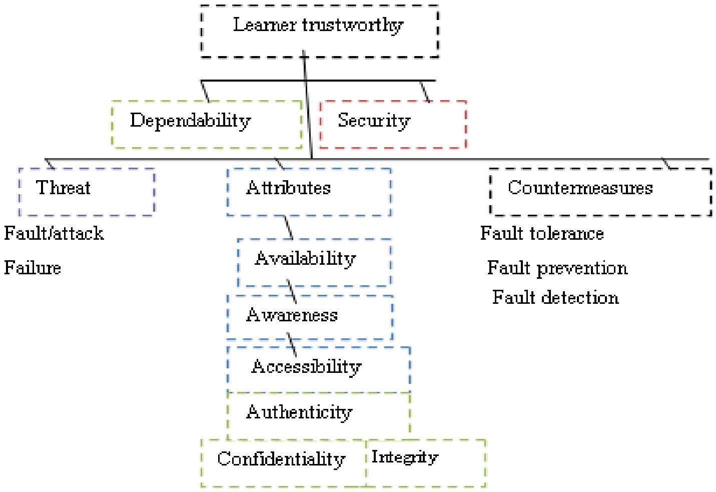

Figure 1. A new classification of dependability and security at learners level trustworthy

4. DISCUSSION AND FUTURE EFFORTS

The research study compromises the overall understanding of new security and dependability integration in mobile learning specifically at learner centric environment.The proposed model was tested emprically using data collection from survey investigating security awareness containing constructs in the model.The study presents an extended technology acceptance model(TAM) evaluation to explore the factors and hyphotheses that affects satisfaction to use mobile learning.The overall model will be validated through mix method of focus group case study and panel expert interviews. The results from the study can be used as additional information when improving or integrating learners' mobile security in mobile learning system and contributes to the body of knowledge of mobile learning security awareness by addressing the identified gaps.

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M-LEARNING PILOT AT SOFIA UNIVERSITY

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ABSTRACT

Many universities have designed specialized Learning Management Systems in order to facilitate the management of education, the access to knowledge and educational resources, and the communications with all stakeholders involved. With the wide spread of mobile technologies nowadays, new challenges emerge for adapting the available systems to the demands of mobile users. The authors present the results of a pilot project of the Department of Software Engineering of Sofia University, Bulgaria, aimed at adapting to the challenges of m-learning.

KEYWORDS

Learning management systems, m-learning, students feedback

1. INTRODUCTION

Last decades are characterised by radical changes in Information and Communication Technologies (ICT) and the emergence of the phenomenon of 'ubiquitous computing' whereas people have access to knowledge and information at any time and everywhere regardless of the device used. Subsequently, deep changes have appeared in the economy and society, and the everyday life of people. The new generations grow with digital devices and gain ICT users' skills at very early age. Therefore, present day students show preference to all forms of distance education available, despite of devices used (Gourova et al, 2013). Mobile learning (m-learning) offers new opportunities for distance education due to the rapid development of wireless communications and the availability of various portable devices. The mass usage of mobile technologies is a reason for the growing popularity of m-learning world-wide (Sampson et al, 2013). At the same time, several challenges emerge for redesign of educational materials and learning standards to suit better the m-learning requirements. The Department of Software Engineering (DSE) of Sofia University (SU) acknowledges the emerging educational and technological trends and tries to provide up-to-date working and learning environment for its staff and students. DSE recently launched deep changes in its web site in order to better suit mobile users, and offered a pilot m-learning to its Master (MSc) students.

The goal of this paper is to present the results of a project launched at DSE. Initially, the DSE problems in providing a Learning Management System (LMS) for its students are outlined, and a concept for solving them is presented. Second, the paper shows the project results after introducing m-learning at DSE, and the students' reflection on the new educational form offered.

2. M-LEARNING DESIGN CONCEPT

DSE provides on its web site public access to its educational resources at Bachelor and Master levels, and information for its activities and educational requirements. A system for Thesis management is accessible from a closed area of the site, as well as internal resources of the staff. In addition, DSE staff uses the common resources of SU, including access to international research data bases provided by SU library, and different web-based systems – for education management ("SUSI"), project management, research publications management (named "The Authors"), and different Moodle platforms. All these systems are installed at different servers and the users need to remember several URLs in order to access them. SU web sites do not provide links to all these systems and single sign in to all resources. Subsequently, despite of all efforts made, DSE faces the need to redesign its web site in order to facilitate the access to the information and knowledge available in all common systems, as well as to ensure user-friendly navigation and visualization of information not only on desktop computers, but also on mobile devices. Therefore, DSE started to assess all resources available on its web site and used by its staff and students, and investigated how to improve their organization, accessibility and visualization on different devices.

Another group of problems which DSE faces concerns the provision of new forms of distance education, namely m-learning. Therefore, it launched a pilot project with a goal to design an integrated m-learning environment for DSE students, accessible via its web site.

For the redesign of DSE web site were taken into account the features of LMS, as well as SU working processes. It was considered the need to ensure scalability, knowledge reuse, efficient searching and retrieval, as well as to provide an intuitive interface and a single entry point to all SU knowledge and administrative resources. It was ecided that the web site should facilitate the following activities:

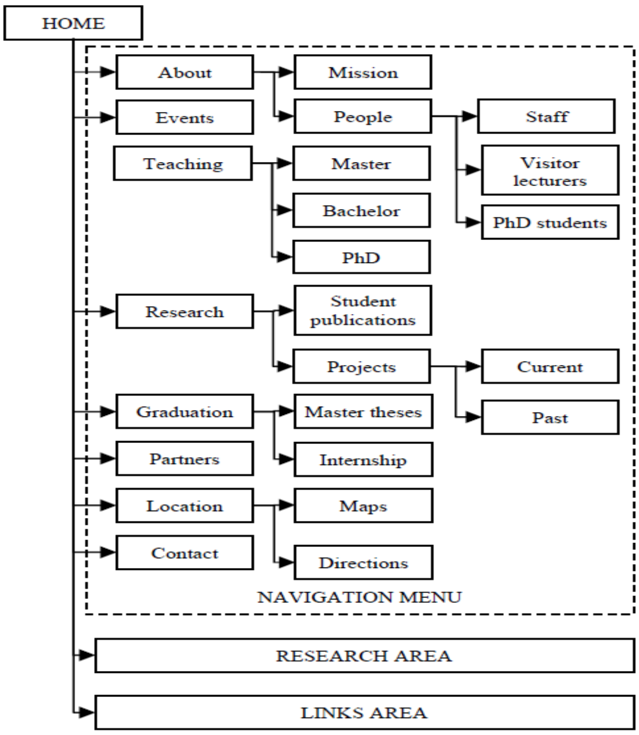
- *Educational activities* – programmes and courses, lecturers, schedules, students' management, students' evaluation, thesis preparation, mobility exchanges;
- *Research activities* – existing scientific infrastructure (labs and equipment, scientific data bases, information flows), project management, intellectual products management, knowledge and technology transfer, collaboration with industry and other stakeholders, scientific supervision and mentoring;
- *Human resources management* – recruitment, monitoring and control, staff assessment and career development, awarding, and teachers' mobility;
- *Administrative management* – planning and reporting, accreditation, resources management.

The concept for the mobile version of the web site was based on well-known requirements for software systems design with mobile access (Ardito et al, 2006; Magal-Royo et al, 2007). The mobile version of the site preserves the former content and resources organisation, however, follows some basic principles:

- Site structure improvement with the aim of more effective, easy and fast access;
- Updating and enhancing content with the aim of its higher informativeness;
- Optimization of the visual users interface with the objective of easy access via different devices;
- Effective web site internationalization in order to easy add new languages.

3. IMPLEMENTATION RESULTS

On bases of the design principles adopted in the concept, the web site was designed with a three-layer interface including: navigation menu, tabular area and links area (Figure 1). The tabular area provides quick access to all research topics of interest for DSE staff. Thus, the web site visitors can navigate easily to different research activities and projects. The links area includes a set of hyperlinks to the common online resources used by lecturers and students (e.g. e-learning system, students' administration system, research database, SU staff research and publications data). They are divided in three main groups: institutions, systems and libraries. As the web site concept envisages effective access abilities by both, mobile devices (phones and tablets) and desktop computers, the DSE team designed one responsive web site that scales across a wide range of screen sizes built on top of jQuery library, HTML5 (HyperText Markup Language) and CSS3 (Cascading Style Sheets). It was also taken into account that the web sites for large screens typically use left or top menus which are not visualized properly on smaller screens. Therefore, using the jQuery library, a dynamic web site menu was implemented which provides quick access to the content. When the browser window is narrow, the navigation in the top pane of the web site converts from a regular three level menu into a dropdown menu. Thus, the users can access easily the menu elements without a need to scroll the web site. Similar transformations are provided for the other web site elements located in the tabular area and links area. As shown on Figure 2, all web site elements like images, titles, texts, etc. are dynamically rearranged when the width of the browser window is reduced (Petrova-Antonova et al., 2013).



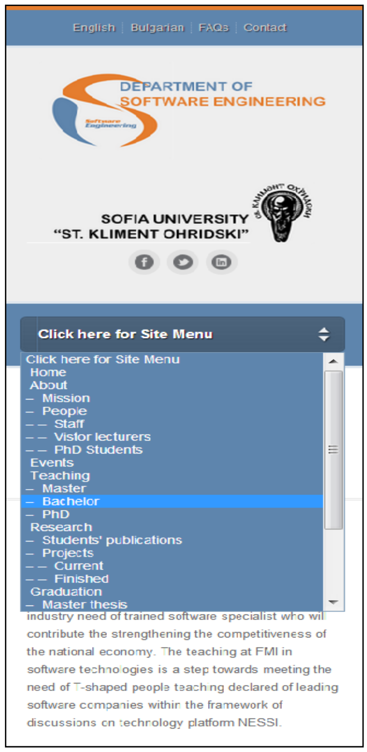


Figure 1. Web site map (Petrova-Antonova-et al., 2013) - Figure 2. Mobile web site menu (Petrova-Antonova-et al., 2013)

The team decided to test m-learning within one MSc course. The questionnaire sent to the students aimed to obtain feedback on educational content and format, and generally on m-learning as a new distance learning opportunity. It is interesting to note that the respondents showed a clear preference of Android (47%) as an operating system of the mobile device, followed by Windows (33%), iOS (5%) and Linux (15%). Students like the opportunity for using mobile devices in distant education, however, they are still not ready to carry out all self-learning activities and interactive communications just in mobile LMS environment. According to the students, key factors for m-learning success are the learners' attitude, the learning process organisation, and the technical opportunities in place. They considered the following opportunities of the mobile LMS:

- *regarding trainees:* to raise learning motivation (more active participation and higher interest to the course), to facilitate individualised learning, to raise awareness of trainees on advanced technology features, to ensure stable and continuous link between users and the learning environment;
- *regarding learning process organisation:* conditions for individualisation and differenciation are in place (38%), better knowledge systematisation opportunities (56%), fast internal assessment of learning results and students' tests (46%), and self-control opportunities (37%);
- *regarding technical features:* availability of fast access to students data, learning modules and assessment results (14%), better users' registration and access management (33%), maintenance of data accessible by trainees, e.g. trainees profile and tasks (29%), everyday monitoring and control by trainers of students performance (56%), learning tasks management using standard approaches and rules (60%), data gathering for students behaviour during the entire learning cycle (34%), standard analysis of learning results and meeting educational goals (84%).

The students feedback shows that m-learning provides a fully new educational design opportunity and environment for: educational materials' storage (23%), distance learning (52%), interactivity on study topics (28%), active students' communications (60%), interactive seminar classes (43%), joint projects work (72%), and online access to educational materials (93%).

Generally, the survey results and the pilot m-learning provide some insight on the new educational forms available, which could facilitate broader individual development, and assist building different competences, skills and personal capabilities on bases of individual plan and learning speed.

4. CONCLUSION

The knowledge gained within the pilot mobile LMS design will be used for its improvement and wider application in the learning process of DSE. This is a base for realisation of new learning tools to be used behind formal education, and especially in courses for further qualification offered to employees providing them 24/7 flexible distance learning opportunities. The project impact is twofold – new forms of learning design are offered, and higher motivation and involvement of trainees in the educational process is achieved. At the same time, the changes of the DSE web site respond to the new technology challenges and facilitate the device-independent access and search of content by university staff and students, as well as enhance their communication opportunities in a user-friendly environment. A further challenge going beyond DSE team responcibilities is to disseminate the project experience and use it for updating other web resources at SU in order to overcome some existing gaps in content access and visualistaion on mobile devices.

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A MOBILE SERVICE ORIENTED MULTIPLE OBJECT TRACKING AUGMENTED REALITY ARCHITECTURE FOR EDUCATION AND LEARNING EXPERIENCES

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ABSTRACT

This paper describes the design of our service-oriented architecture to support mobile multiple object tracking augmented reality applications applied to education and learning scenarios. The architecture is composed of a mobile multiple object tracking augmented reality client, a web service framework, and dynamic content providers. Tracking of multiple real objects and retrieval of associated multiple media contents allows more complex augmented reality learning scenarios to be constructed that could improve students' knowledge and learning strategies on a mobile platform. It also allows students to create their own augmented reality learning environments and select preferences from acquired digital contents based on multiple object real scenes. Mobile users are able to request contextual digital contents from web service providers to augment these multiple objects in the real world. The digital contents are generally dynamically acquired digital media, e.g. 3D models, images, textual descriptive data, metadata, multimedia or even social media data. New digital contents for augmenting the real world are acquired through a service-oriented approach by accessing any appropriate web services to deliver that content to the augmented learning environment.

KEYWORDS

Service Oriented Architecture, Augmented Reality, Multiple Object Tracking, Dynamic Digital Media Contents

1. INTRODUCTION

Augmented reality is a concept for displaying digital contents overlaid on top of real world scenes that can enhance remarkably a user's learning experiences. Augmented reality (AR) utilizes advanced computer vision and tracking techniques to recognize markers, images or 3D objects in the real environment and uses this information to augment the physical space with computer generated media contents, such as 3D models, sound, images, videos, texts, etc. (Damiani et al., 2011). AR is generally implemented through various different approaches and platforms such as location based AR systems, indoor applications and edutainment (Krevelen&Poelman, 2010).

One of the current challenges for AR technology is to implement effective AR on mobile platforms. Mobile AR has become a most recent trend in location based services and interactive graphic applications that allow users to experience visualization and interaction with 3D models or contents on mobile devices. Currently, mobile AR has also been implemented efficiently in various innovative applications such as gaming, shopping guides, advertising, edutainment, travel guides, museum guides and medical visualization (Papagiannakis et al., 2008). These applications can be enhanced by adapting the visualization, tracking, recognition, interaction, displays and user interface techniques with real world scenes and virtual environments (Zhou et al., 2008)(Pery et al., 2011).

Nowadays, AR technology has become a powerful tool to enhance education and learning experiences by visualizing 3D virtual contents on mobile technology (Kesim&Ozarslan, 2012)(Wu et al., 2013). Students are able to view digital contents augmented in real scenes using tracking techniques or even current location on mobile devices such as a smartphone or tablet. Interaction between students and digital contents can also be done on AR environments for indoor or outdoor uses. To do so, educational content providers or teachers can design what they want their students to learn the physical objects and augmented digital contents. On the other hand, it would be a useful and innovative way to extensively enhance students' learning experiences by providing a tool (mobile AR client) to create their AR learning environments. Students could personalize their AR learning environment by selecting preferred contents (e.g. by age, gender, etc.) associated with the reference objects tracked in the real world. Content service providers provide these digital contents, which are then displayed in AR environment — the resulting AR environment can be saved and reused for presentation again in other different learning experiences.

There are some tools that enable mobile users to create their own AR channels for indoor and outdoor environments such as Junaio (www.junaio.com), Layar (www.layar.com) and Aurasma (www.aurasma.com). These applications enable mobile users to create AR environments and save them into their channels on the cloud server. This technique is useful because it allows general mobile users who don't want to or who can't develop mobile AR applications to have their own AR environments. However, these AR applications still have some limitations because they are implemented on closed platforms such that a user's AR environment can only be retrieved via the commercial application, i.e. you cannot reuse a Junaio environment in an Aurasma environment. Moreover, most commercial mobile indoor AR applications provide users with limited amounts of data or contents for augmenting real world scenes. There is no communication channel for current AR applications (e.g. Junaio, Layar, Aurasma or specific research application like an AR game, etc.) that allows them to download or obtain dynamic contents from other third party data sources in real-time — our solution proposes an open model for accessing contents via web services. Hence, there is no content sharing between mobile users and service providers limiting digital content acquisition to the mobile AR application builder's pre-design contents built into their applications.

This paper presents the design of a multiple object tracking AR architecture on a mobile platform that exploits service-orientation to access digital media contents that could be beneficially applied in learning and education scenarios. Our architecture provides a mobile AR learning environment with access to other digital content generation services such as photogrammetry, or third party content requests, in order to obtain associated 3D or digital media contents. Such contents, selected dynamically and based on multiple object tracking, provide for novel learning scenarios, as students will be able to create personal AR environments on real scenes for each different learning situations by utilizing camera-embedded mobile devices.

2. SERVICE ORIENTED MOBILE AUGMENTED REALITY SYSTEM

Our mobile AR system exploits the concept of service orientation to implement its software architecture as a designed pattern based on distributed system components that provide application functionality via a set of web services (http://msdn.microsoft.com/en-us/library/bb972929.aspx). The service-oriented architecture is largely composed of 3 components: the mobile multiple object tracking AR client (web service calls), the web service framework itself, and participating dynamic digital content service providers (web service calls). The web service framework is designed to link and manage connections between the mobile AR client and web services content providers over wireless or mobile network. Mobile users will utilize the mobile AR client in order to perform general AR tasks such as multiple object tracking, interaction and content visualization. Moreover, users can also request for additional contents and services from open service providers such as a photogrammetry service so that they can decide what to place and manipulate on the AR learning environments. Figure 1 shows the service-oriented architecture for a mobile multiple object tracking AR system and a test screenshot illustrating the AR application on an iPhone 5, which utilizing the Metaio AR SDK (www.metaio.com/sdk/) to track the 3D biscuit tube container. Once the biscuit tube is tracked, 3 pieces of associated digital media data (a 3D model, a price tag and an image) augment the real world scene.

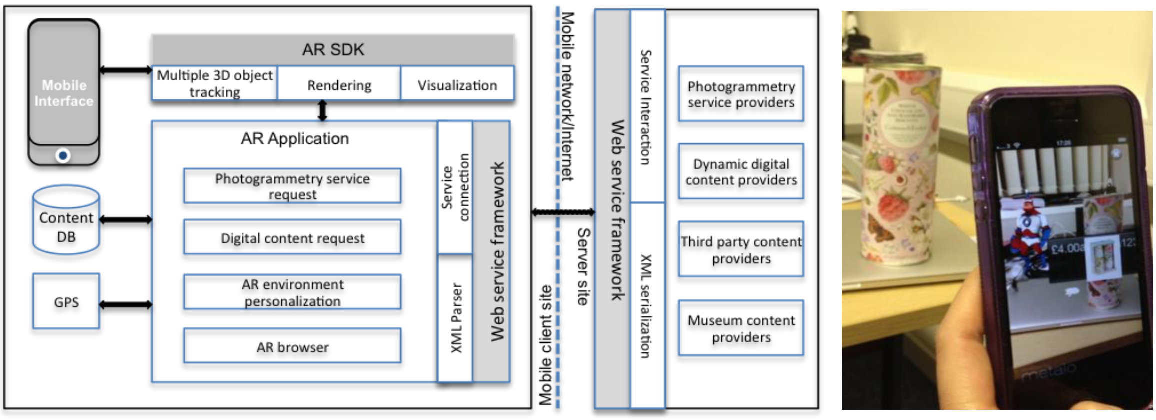

Figure 1. Service-oriented architecture with multiple objects tracking on a mobile AR system

Other example learning scenarios could involve utilizing the video frames taken of the physical 3D object (e.g. the biscuit tube) to request a 3D model build via a photogrammetry service for later use by the learner.

3. WEB SERVICE FRAMEWORK

Integrating a service oriented architecture and web service framework into any application generally provides more value and usability for the platform of applications (devices, architectures, software), and this includes mobile AR platforms (Belimpasakis et al, 2012)(Wang&Wang, 2008). Interoperable AR applications are projected to present virtual media or digital contents on see-through AR browsers, which can be used instead of web browsers in the outdoor AR environment (Lee, 2009)(Selonen, 2012). Open and interoperable networks are based on service-oriented architectures, and consequently can be accessed over the Internet through mobile network and client-server architectures. Examples of web services, which developers can easily access to generate platform independent digital contents, include Web Map Services, mash-up services, geospatial and social network data, 3D models, etc.

In this research, the web service framework is combined into a mobile AR application and set of example web service providers to provide service interfaces and connections to appropriate digital contents for the mobile AR client. In a mobile AR learning environment, the mobile client is able to request services and receive related dynamic media contents for viewing and manipulating in the AR environment, see screen shot in Figure 1.

4. EDUCATION AND LEARNING SCENARIOS

We designed the multiple objects tracking AR client as an application on mobile devices, where the web service framework will work as a back-end system. Our goal is to create a mobile AR client with a service-oriented architecture that is adaptable and will be able to support various mobile AR leaning scenarios. There are interesting issues that arise when considering mobile AR system and service-orientation:

- Sharing learning materials such as animation, 2D/3D models, images or videos over the Internet. Students will be able to download and place their prospective contents on AR environments by identifying marker or markerless (e.g. 3D) objects to each real world scene. Additionally, newly acquired contents integrated in existing AR environments could then be visualized in other situations.
- General mobile AR applications mainly require tracking, rendering and visualization tasks, for which the final outcome of a reference or tracked object will be revealed on the screen. Existing tracking techniques that would be efficiently developed on mobile AR platform are marker, markerless (2D and 3D) and location based tracking. Markerless tracking augments digital contents on top of real scenes where mobile users will see a combination between computer-generated media

contents and the real environment. In addition, 3D tracking, see Figure 1, is outstanding in its ability to visualizes virtual contents augmented with the 3D object tracked — this greatly increases the application range for AR scenarios, one can imagine for example a museum's physical artifact or object being augmented with associated dynamic media objects.

- A good illustration of a learning scenario for our mobile service oriented AR platform would be where a museum visitor wishes to access further information about a physical artifact on display. In such a scenario, typically the museum's artifact will only have a card presenting the curators interpretation of the artifact. The visitor is able to use either the card itself as a trigger image to reveal more augmented contents, but more interestingly they will also be able to take several images of the object and use a photogrammetry service to reconstruct the object in 3D and then personalize that object with the existing augmented contents for visualizing and learning outside the museum, thus generating their own interactive learning preferences by selecting, manipulating and placing preferred contents on AR environments.

5. AUGMENTED REALITY IN LEARNING ENVIRONMENTS

AR techniques can enhance students' learning experiences by presenting media contents overlaid on reference markers or markerless tracking objects. Students will be able to learn from augmented media contents relative to the real environments objects, which is more interesting and adaptable than reading books or viewing images. This paper proposes the application of AR technology on a mobile platform and web service architecture, which efficiently enhances education and learning scenarios by offering some features for students to acquire new and various contents from appropriate services and also create their own AR learning environments. The following issues improvements to current AR systems through a service-orientation integrated with the learning environments.

- General AR applications or even AR in education are often offered in closed platforms that enable users to only view AR contents overlaid on a marker. The contents could be 3D models, images, videos, etc. that have relevance to lessons or learning scenarios that the teachers or content providers want to offer. In contrast, in our system, we design an open AR web service architecture on a mobile platform that allows users to acquire and view more associated contents from open service providers.
- Multiple object tracking is a feature in our system that enable users to track 3D objects rather than tracking markers or markerless such as 2D images or photographs, which is typically found in general AR applications. This will improve learning techniques by augmenting real objects, offer new views, and allow the users to acquire associated contents in order to learn through AR environments.
- Photogrammetry services and AR environment personalization are also features that allow users to acquire 3D models from real objects by requesting image-based reconstruction services, which can then also be used to create personal AR environments for taking away and viewing in different situations. These features cannot be found in typical AR applications for education or learning up to now — students currently are not be able to obtain new associated media contents or save and manipulate offered AR environments. Therefore, the learning processes will be enhanced from small scale to large-scale AR environments by utilizing our mobile web service AR architecture.

6. CONCLUSION

The service-oriented mobile multiple object tracking AR system is designed to efficiently support a web service connection and AR environment manipulation feature for mobile AR applications, which could benefit learning and education scenarios. The proposed mobile AR application could provide students with an AR web service framework allowing them to request dynamic digital media contents from open source digital content providers. Currently, the architecture can detect multiple 3D objects and assign multiple digital contents to the detected object in the AR environment. It is also able to connect to a web service provider via wireless/mobile network in order to request associated media contents and overlay those on the real scene. The next steps are to detect multiple objects in parallel, add meaning to multiple objects thus detected and so modify the augmented digital contents based on the meaning of, say two objects tracked, and so on. Utilizing third party contents through this architecture's web service has many obvious benefits over current closed commercial AR systems.

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Reflection Papers

LEARNERS' ENSEMBLE BASED SECURITY CONCEPTUAL MODEL FOR M-LEARNING SYSTEM IN MALAYSIAN HIGHER LEARNING INSTITUTION

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ABSTRACT

M-Learning has a potential to improve efficiency in the education sector and has a tendency to grow advance and transform the learning environment in the future. Yet there are challenges in many areas faced when introducing and implementing m-learning. The learner centered attribute in mobile learning implies deployment in untrustworthy learning environment, which introduces high mobile threats. Security is an unfocused issue even though statistically proven that threats are increasing each day on mobile application and ensemble devices. The research question deals with how a security conceptual model could be derived and constructed to address the mentioned threats without introducing high security gadgets or restraining the mobile learners' performance. Available literature has been studied; revised and discussed .The salient characteristics as well as the drawbacks of current countermeasures were explored. The model is based on the definition of dependability with security integration and a dynamic mobile learner's satisfaction in security trustworthiness was defined. This study however selected to focus on mobile technology threat and vulnerabilities along with the solutions and countermeasures to be viewed with appropriate guidelines, awareness, standards and best practices. The findings in this study therefore represent a multiple view of mobile learners' trustworthiness in a m-learning environment. The model was constructed to be compatible to be efficient and competent, giving the m-learning users insight into potential security threats as well as tools for maximum protection against malicious and non malicious attack.

KEYWORDS

M-Learning, ensemble devices, learners', security conceptual model

1. INTRODUCTION

Nowadays mobile devices are highly present and well integrated into learners' everyday life. Aspect related to mobile security adoption had never been seen in previous studies. Researchers have performed an empirical study on the adoption of a student toward mobile learning in their formal learning activities and type of content to be delivered. Nevertheless research study on students or users security awareness towards mobile devices and mobile computing in m-learning. Mobile learning is a new learning enhancement yet to be analyzed and explored in the South East Asia developing country such as Malaysia which has already begun to adapt to this new technology in early 2009. Several researchers have used surveys of students and university lecturers as their starting point for investigating m-learning adoption and readiness. There have been increasing numbers of investigation studies of m-learning over the last few years, in Malaysia. The survey is conducted to identify the literature gap in mobile learning specifically on mobile user security perspectives. The uniqueness of this research is to identify the literature gaps in the direction in a secure learning for mobile learning users in Malaysia Higher Learning Institution beyond traditional security theory. As a result a gap has been distinguished from breadth analysis of the literature example security and dependability with the evaluation factors such as satisfaction in the trustworthy domain. The contribution of the proposed conceptual model is to improve existing m-learning frameworks and models, where security threats and countermeasures are mapped with the dependability attributes to focus both dependability and security in a unified model to generate trustworthiness in m-learning learners.

2. PROBLEM STATEMENT

Despite the great interest of the universities as well as the ministry to engage the digital technologies and making the learning of all students more interactive and supported anywhere, anytime and on the go there are still many questions which are urgently needed to be investigated. Through detail analysis in the literature by (Ariffin, 2011; Jacob, S.M., & Issac, 2007; Litchfield, Dyson, & Lawrence, 2007; Rachel, Cobcroft, Towers, Smith, & Bruns, 2006; Rajasingham, 2011; Rapetti, Picco, & Vannini, 2011; Sabeeh, 2011; M. . Sharples, 2006; Cobcroft, 2006;Naismith, L. &Corlett,2006; M. Sharples, Taylor, & Vavoula, 2007) as described below:

i. There is a major need for secure platform for large scale implementations across a range of subject areas and discipline across Higher Learning Institution.
ii. Security knowledge and awareness of learning and teaching principles and strategies is urgently needed to use mobile technologies and inform the development of Higher Education Strategic Plan and Government Policy about the emerging ensemble mobile devices.
iii. There is a great demand for investigation of security countermeasures and solutions to implementing mobile learning in a secure platform so that it can be reliable and sustainable in the future.
iv. Investigations are needed to develop security strategies for effective learning about future and current mobile technologies and ensemble mobile devices

After analyzing the overall literature, the derived problem statements above were developed with references from several established workshops, conference and international official bodies' security report.Mobile Learning(m-Learning) has become a challenging platform to be implemented in global and in Malaysia Higher Learning Institution. Vulnerability issues in mobile and ensemble technologies are becoming famous devices for attackers, due to lots of ad-hoc mobile, high penetration of mobile devices and lack of user security awareness on mobile devices. The rapid growth of mobile computing in m-learning environment has a big question on the learners' acceptance, trust and satisfaction use the content and application which address to security issues.

2.1 Research Question

The research question that is addressed in this paper deals with how security model can be constructed to resolve the mobile learning problem without introducing high cost or restraining the mobile technologies and ensemble computing mobility, performance and lightweight operation. In order to further discuss and identify the research problem three sub research questions are constructed in the Table 1 below:

Table 1. Sub Research Question

No	Research Question
RQ1	What are the security issues faced by learners in the m - learning system and ensemble mobile computing?
RQ2	Are there models that can be used to evaluate the m-learning system's learner's satisfaction and trustworthiness, in terms of security and dependability behavior?
RQ3	How to improve the success of addressing to security issues at the learners level in the m - learning system?

2.2 Research Aim

The research aims to inform readers of suggested direction for researching how secure mobile environment can enhance learners' trustworthiness and satisfaction to accept and use the m-learning system. These directions are informed by a survey and contemporary literature search.

2.3 Proposed Model

There are similarity striking between dependability and security concepts which the end product satisfaction and fitness for use that include availability, accessibility and awareness. The other attributes of security has and external relationship of dependability which also could work together and posed as a minor attribute. M-learning is a sophisticated learning system which is developed to provide services that place great trust for learners and providers. As suggested earlier by (Sheila.M, 2012) here Figure 1 is an integrated system model dependability and security is highly needed to describe the system in terms of accessibility, availability, behavioral and protective characteristic, in which this complete combination would produce a trusted system. From the literature, variables and parameters are derived to evaluate and validate the proposed model. “Learners Based Security Conceptual Model” is dependant to three major independent variables: threat countermeasures’, user satisfaction and trustworthiness and Standards & Guidelines. The example Figure 2 illustrates the interaction between learners and well established trusted system domain knowledge. Trust of user is measured in service based given to the learners. Parameters or indicators involved to assess the trust of services or availability, accessibility and awareness. The characteristic of trust could be described as level of service being rendered to the satisfaction of the learners and confidence.

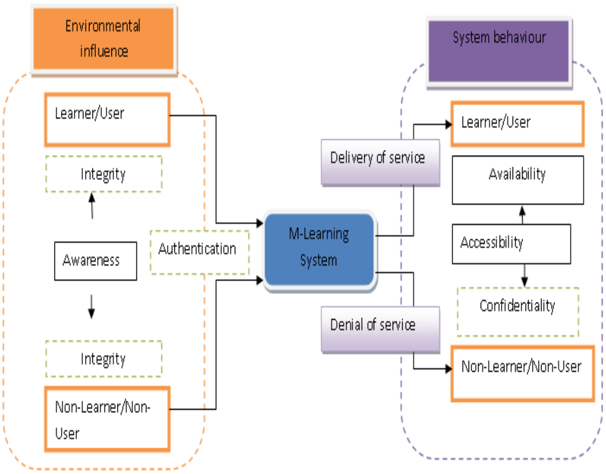

Figure 1. Learner Centric Security Model

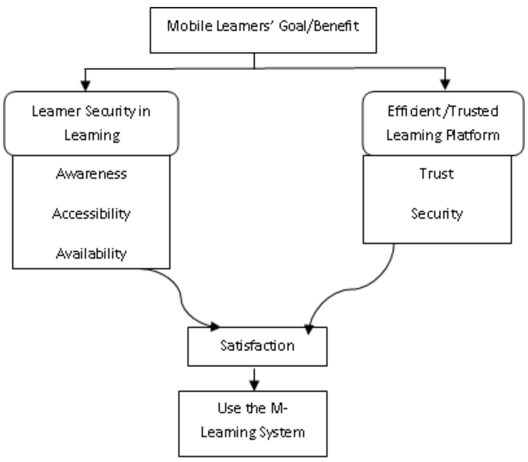

Figure 2. Learner Trusted System Domain Knowledge

Evaluation of the model is categorized into three sections. An extended conceptual model of user satisfaction based on security for learner centered m-learning system is derived to ensure the learners in the m - learning system to get trust of service levels coupled with what they are asked for. Table 2 describes the evaluation method and results related to the research questions.

Table 2. Mapping research question with evaluation method and result

Research Question	Evaluation Method and Result
RQ1	Trust of service at learners’ level can be classified as the key measurement of physical attributes of the mobile device user by learners, behavior attributes subjective to learners’ awareness surveys.
RQ2	The model is evaluated by interviewing panel experts which they understand the reality of mobile technology and value of security implementation of m-learning systems in higher learning institutions
RQ3	Comparative analysis is conducted to analyze the theoretical study and the empirical study result with the current threats involved at user level.

3. CONCLUSION

The research work focus on learner’s security in mobile learning and how it is important to ensure that all information within the mobile learning environment is properly protected; to gain confidence towards learners and providers by addressing the security requirement in m-learning system for the primary process: developing content or application, teaching & learning environment and university governance. The Proposed model contains the definition, the user’s view of m-learning operation, assumption, readiness and assertions. The work is not to propose new solutions to security problems, but it indirectly proposed protection mechanisms that can be used to secure the device against attacks and propose a complete learners security conceptual model where various countermeasures , best practices , policy , guidelines reside.

ACKNOWLEDGEMENT

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SUPPORTING THE M-LEARNING BASED KNOWLEDGE TRANSFER IN UNIVERSITY EDUCATION AND CORPORATE SECTOR

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ABSTRACT

The evolution of today's connective forms of teaching and learning draws attention to expansion of 'space ' in which teaching and learning moments: engaging the attention, knowledge transfer, acquisition, demonstration, experience, experiment research and practice, conclusions are organized around a more free method. Due to these phenomena and the previous experience gained, the aim of the article is to present the possibilities of mobile learning and ICT-based environment. It shows how the mobile device based (independent of place and time) short content access, control of learning self-issues, customized test questions (centralized storage of results) or per item assessed curriculum can be implemented. In the background of the solutions presented are assessments of a 2012 and 2013 based empirical studies carried out among an electronic framework and online forms. The results support the need for a new type of mobile learning support systems.

KEYWORDS

ICT, mobile learning environment, micro content, digital communications, knowledge management, m-learning

1. INTRODUCTION

The main feature of the information society is that the information has become primary value. Because of economic globalization and corporate governance crisis the main engine of information society is computer technology and the rapid development of telecommunications, its most important stages are the spread about of personal computers and the emergence of broadband networks, its symbolic technological innovations are the Internet and mobile phones. As the result of this rapid development no area of life can avoid the application of information technology. It also involves important social changes: the rate of employment in the information sector grows dramatically, telework and life- long learning becomes possible and necessary the same time. As a result, the development of digital literacy and the dissemination of information infrastructure may appear as primary strategic objective. The same time, living in the information society, people may face many previously unknown problems such as unlimited quantity, but various quality of available information, which needs proper assessment, filtering and processing or the protection of privacy over control of economic or political powers. This effects the environment of the society. The nature of work is changing, the changes are related to the individual learning processes, attitudes, developed learning habits, or the altered teacher and student roles [1],[2].

2. HISTORY

Higher education institutions have begun to adapt to the new generation of student attitudes, customs and learning style, which are switching to e-learning based educational systems. As a result the e-learning environment is introduced and operated by educational institutions. Such a learning environment can be created using Moodle, Olat, Ilias, Claroline, or CooSpace systems, some of which are present in higher education administration and educational system, such as Neptune, ETR, and operated in synchronized connection. Also, another trend is video capture and online sharing of university lessons by institutions.

Using this system, the multi-annual higher education experience in micro and macro level has shown that while the teaching activities in the learning environment can be made mostly in the daytime period, while most of the students' activities are in the late evening or night (full-time pupils). And the aforementioned online, Web-based learning support systems ensure continuous communication between network nodes in synchronous or asynchronous format, which means the new type of student-instructor communication.

The current teacher training courses (graduate and postgraduate training) at Budapest University of Technology and Economics, Department of Technical Education have gone through a paradigm shift. Namely, had to give up the curriculum-centered, teaching-oriented traditional learning theories and methods, and instead has switched to the so-called ICT-based atypical learning forms.

This attitude change in education can be supported by different ways and tools. In the world of the interactive ICT-based systems and digital natives (who are today's information society generation) smartphones, iPads, Kinect units and associated interactive games as well as a range of network-based Web2.0 services, (for example shared documents, presentations, electronic surveys, mobile applications, shared calendars, blogs, social networking sites producing a realistic simulation online tests, shared calendars (Google)), 3D worlds (Leonar3Do), and finally, the virtual environments (Second life) all support learning. These systems and mobile devices are necessary for the use of the so-called “new media skills” learning [3].

2.1 M-Learning in the Teaching-Learning Process

Under the concept of m-learning in general we refer to learning activities done on any mobile device and learning content available from anywhere. Specifically, the type of learning, where an existing online CMS, LMS system can be reached from any network device suitable for mobile communication. These conditions are primarily met in case of smartphones, tablet PCs. For example a Samsung Galaxy Tab touchscreen Android device is suitable for web browsing and multimedia ready. Mobile devices are limited by the intelligence of available content (Web 2.0, flash, audio, video). The smartphones are running on different operating systems, which makes it difficult to meet various compatibility. Such system has long been known as Symbian, Windows Phone, Android, Apple iOS, Bada and Blackberry platforms. The other major challenge to this means that online content should be provided by a seamless content management system and optimized for web (custom CSS, optimized content). In addition to all of these aspects are various existing m-learning opportunities. Many of the developments also point in this direction, for example the well-known Moodle LMS system will be ready soon in a version of official Moodle mobile client as well. This sub-chapter and subject of research is dealing with the iPad as a mobile communication device that is capable of supporting M-learning [4].

2.2 The Micro Content (μ content)

As new and faster forms of communication are discovered, we immediately try to involve them in the education process. Inherent in these experiments is the initial large flare ("this new form will solve everything"), and the disillusion ("it may not solve all problems and learning difficulties"), massive disappointment ("so far it looked good, but I do not believe that could be really useful") and agreement ("and in this particular learning situation it is good, more than anything else to be found"). The technical possibilities for expansion follow the English-speaking world’s learning terms: learning , distance learning (d) , flexible learning (f) , electric learning (e) , blended learning (b) , mobile or micro learning (m), nano-learning (n). In Hungary, e-learning term has been agreed, the professionals and the wider range of interested parties agreed on its importance, but it is far from being surrounded by so much fanfare, as it was before (for example, the government supported developments have been completed, but the corporate sector has a preference for it nonetheless). The m-learning (mobile-learning or micro-learning) is so new that we are not through even with the initial stage. The micro content’s whole point is to relieve the stress nature of our fast world, highlight the corresponding nodes, wrap information in particular size (300 * 500 pixels), incorporate visual elements and corresponding interfaces into space limitations through compliance. The following figure shows an example of such a micro-content [5].

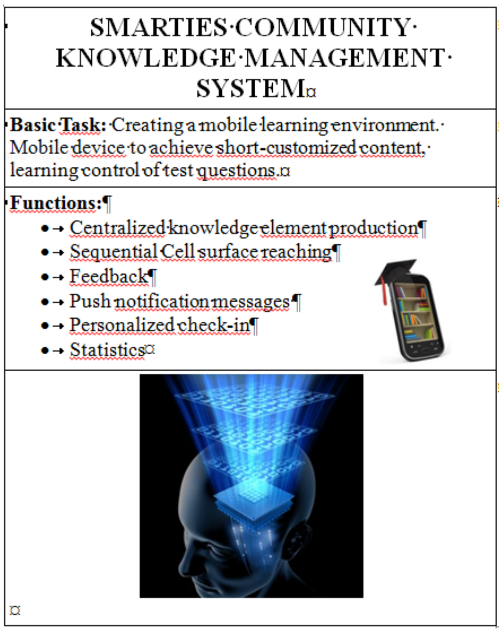

Figure 1. Example of such a micro-content. Source: own figure

3. PREZENTATION OF THE EMPIRICAL RESEARCH

3.1 Characteristics of the Study and the Circumstances

The survey took place between 2013. September 10 and 25 with the involvement of individual units within the BKV and MÁV. The study questionnaire was made with the Google form designer and form sheet. The introductory survey questions were supposed to explore the sociological characteristics of individual respondents, they enquired about equipment requirements, use of knowledge, and assessed the capability of the application of the modern distance education methods. 73 people attended the anonymous data reporting. Of these, 64 worked at BKV and 9 were employees of the MÁV. Target segment of the study included all selected, as employees engaged in intellectual work or work in lower and middle management at their workplace.

The assessment was made with the respondents involved. Accordingly, the results revealed can only be locally representative. Representativeness in a general sense, cannot be applied nationally to the identified characteristics in other companies, or only with significant restrictions to the interpreted data. Isomorphic representativeness therefore replaced with the homomorphic approach. In order for the results to be interpreted in other areas in connection with other companies, in the following we intend to establish characteristic of the sample rate of 95 % confidence intervals. In case of companies with these characteristics which fall within the confidence intervals, the results can be accepted without reservation (the survey is representative) . The greater differences can be observed for a particular company, the more necessary is for the results to be taken as approximates.

3.2 The Results of the Survey is Used in the Context

In respect of communications modes used the 3 spaces of communication do not differ. Both in business, workplace and private communication of e-mail, telephone calls and personal conversation (negotiation) is dominant. Also, all three spaces are limited area of SMS expression. The traditional mailing, chatting, Skype and Facebook use and communication using framework is negligible.

In terms of means of communication the 3 spaces are very similar to one another, smaller (but significant) differences may discovered between them. All of them feature primary orality (exluzive of any devices), desktop computer (with the exception of private communications, where laptop and smartphone are increasingly taking over the role). The use of the traditional postal services are increasingly pushed to the background, the IP phone, video phone, tablet, notebook and netbook is not widespread.

In corporate training based on e-learning 86% of employees would participate, 44% of them study with desktop (not mobile) computer. The majority (82%) would use their own devices, but there is a significant proportion of those (22%) who would learn with tablet provided by their company. The further training could take 2 hours a week for an average respondent, but every 9th respondent would learn 5 hours a week, one in six would dedicate less than an hour a week.

In respondent segments the most noticeable difference is between the sexes. Women use more varied forms and tools of communication, but in case of some higher priced means generally men are early adopters. In terms of education there were significantly less differences, but it can be said that the more educated use a wider spectrum of modes and instruments. Analysis from the position taken in company show that only a few differences can be seen. Generally speaking, the lower-level level employees use bigger variety of tools to communicate. The rest of the analysis did not show significant differences.

Among the respondents the awareness of the teachers' group in forms and means of communication is significantly higher than among the others. The use these means in different spaces (work, private, etc) is both higher than the use of others, and the spectrum is wider too.

Testing latent variables clarify that with minor differences in both test target groups (private sector, public education) in all communications arena personal conversations, e-mailing and phone calls are the crucial method, while the primary orality, a desktop computer and phone (mostly traditional version) are the tools most often used. Between the two spheres there are a number of minor differences that can be revealed, but in whole they do not affect the high degree of similarity.

4. CONCLUSIONS AND FURTHER DEVELOPMENTS

Formulated from the view of micro-content, based on the results of the needs assessment study, a management client-side software development system is to be developed which can simply and easily create micro-content, utilizing the capabilities of smart phones with multimedia (images, text, audio and video). Formulated from the view of the client-side framework, the use of Android mobile phone operating system is preferred. The m-learning framework has been in the construction phase and will be able to manage the following activities:

- Centralized knowledge element production
- Sequential mobile phone reaching
- Feedback between users and content producers
- Sending push notification messages (e.g. when new content is embedded into the system)
- Personalized check-in
- Statistics on activity and result accountability

In order to develop the tasks above during the planning process we set a complex independent relationship graph which is shown in the following figure. The first demo of the m-learning system is based on this.

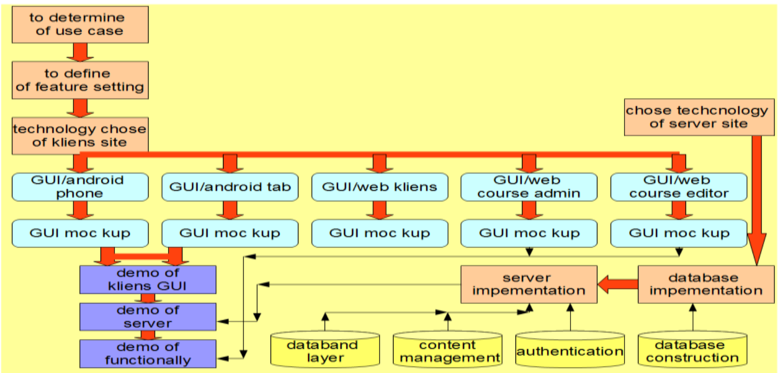

Figure 2. Server-side client dependency graph. Source: own figure

The following figure shows the client-side interface on Xamarin surface running a simulation.

Figure 3. Client-side user interface development environment. Source: own figure

The results of the research disseminated bring plans which include further development of the clear predictions of correct and preferred ICT-based learning programs.

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Poster

THE FUTURE OF UBIQUITOUS ELEARNING

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ABSTRACT

Post-secondary students are increasingly receiving instruction by eLearning. Many or these are part-time students or are working while taking classes. In such circumstances, students may find themselves short of time to study. One mechanism that can be exploited to make the best use of available time is ubiquitous eLearning. Ubiquitous eLearning can take place at any place, at any time and is enabled by mobile computing devices such as laptops, tablets, and especially smart phones. In this poster paper, we present our initial thoughts on how sensor-filled mobile computing devices will enable ubiquitous eLearning. We also will present in the poster the results of our latest experimentations, which will be carried out in January and February 2014 on the modeling and prototyping of ubiquitous eLearning environments.

KEYWORDS

Ubiquitous learning , mobile learning, collaborative learning.

1. INTRODUCTION

Ubiquitous computing (sometimes called pervasive computing) creates ambient intelligence where environmentally embedded devices provide continuous, unobtrusive and reliable connectivity and computation while performing value added services [9, 10]. Ubiquitous computing implies an ability to adapt to environmental conditions, which are determined by sensors [1, 7]. Several experimental systems have recently been described which apply ubiquitous computing to the e-learning application [2, 3, 4]. Other researchers have described the challenges in adapting learning material to the ubiquitous learning environment [5, 6, 8]. These approaches often target primary and secondary learners. Our research is oriented towards post-secondary, working or part-time students who have a limited amount of time to devote to their studies. Many of our students fit in this category. They may need to fit their studying into slack times such as: commuting; between appointments; while on vacation; etc.

2. APPROACH

In our approach to ubiquitous e-Learning, the learning materials must be optimized to run on mobile computing devices such as smart phones and tablets. However, our approach goes beyond this. Given the non-conventional study environment, our students may face a number of different obstacles to effective learning: noise; motion; low light conditions; etc. Such obstacles can lessen the students' concentration. Students also may have different amounts of time available for them to study. These conditions and more make up the students **ubiquitous learning environment**. The students' computing platform must not only present the materials to them, but to add the most value, it must perform situational identification [9] in order to present relevant and timely learning materials. Such situational identification relies on learner profiles [4, 5, 8] which are commonly used in e-Learning, but also on the use of sensors [7], to determine the situation the learner finds himself in, and to present the most appropriate material. Smart phones and tablets which are commonly used devices by today's students contain a variety of sensors which could be exploited for situation identification. Table 1 lists the sensors in the iPhone 5. In addition, of course, there are built-in camera, microphone, GPS, etc. Ambient lighting and noise, motion detectors, etc. can be used to determine that a student's environment is best suited for easier material, rather than more rigorous material. Such a determination requires **sensor fusion**. This information can be combined with information from the learner profile to determine, for example, that the student is currently in a commuting experience and has a certain amount of time, say 30 minutes, available for study. This can determine an appropriate chunk of learning material to present to the students. This requires a more general **information fusion** process. Learning materials need to be classified as to length, difficulty, and ordering, following standards, where they exist. As a further example, the camera can be used to sense by a student's facial expression that he is puzzled by the current material, and hence a review session should be triggered.

Table 1. iPhone 5 built-in sensors

Sensor	Use
Proximity sensor	Senses when display is close to face
Ambient light sensor	Can be used to adjust brightness of display
Accelerometer	Can be used to change screen orientation and for games
Magnetometer	Measure strength and/or direction of magnetic field
Gyroscopic sensor	Increases motion perception

3. FUTURE RESEARCH

We are currently developing a model of ubiquitous learning based on concepts such as sensors, learning profile, learning community (via social network technology), situation definition, sensor fusion, and information fusion. This model is being used to develop a prototype ubiquitous eLearning system. Both the model and prototype system incorporate our previous research in eLearning [11, 12] and will be presented in the poster.

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