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 process of learning 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: Samkela is at home reading the notes that he copied during class from the board written in English. Samkela stumbles across a fact he does not understand. Samkela tries to reinterpret this concept in Setswana, translating word for word what the concept means. In their home environment Samkela 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).

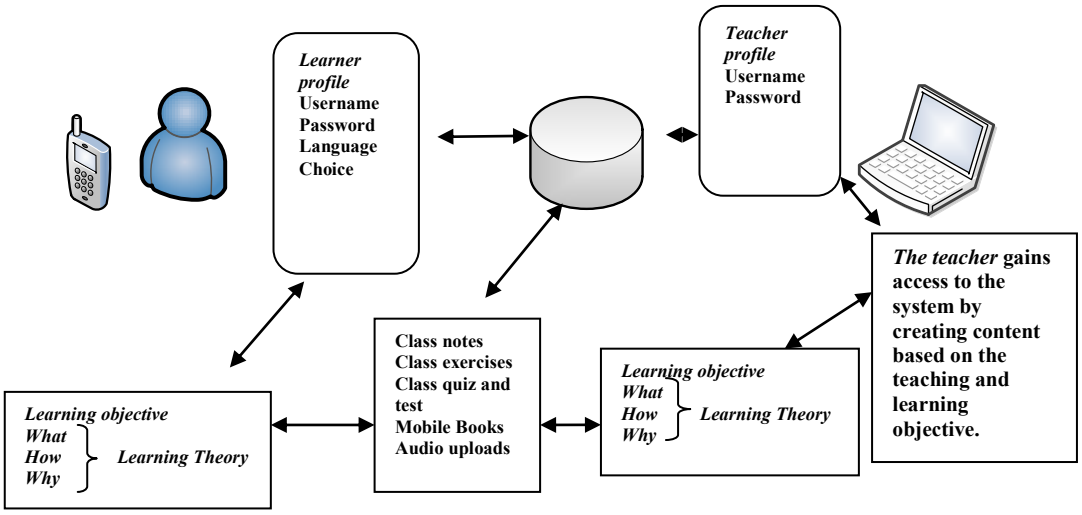

Figure 1. System Architecture

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).

3.1.2 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 Heyssteen *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 can be used to support multilingual learning.

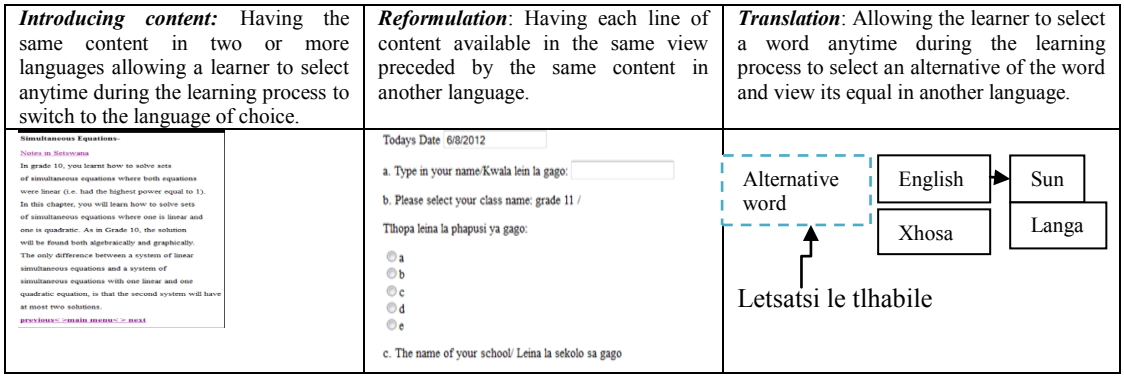

Figure 2. The content presentation approaches

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 chartrooms 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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