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Supporting E-Learning in Computer-poor Environments by Combining OER, Cloud Services and Mobile Learning

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Abstract: Research supervision is an important type of support for advanced students when engaged in study projects or in writing their final theses. One of the most common complaints from research students is erratic or infrequent contact with supervisors, who might be too busy with other responsibilities or are not present frequently enough . High proliferation of mobile phones(i.e. 'mobile-rich') but no computer prevalence (i.e. 'computer-poor') in African countries calls for using mobile technologies to address this challenge. However, limitations of mobile devices (such as usage cost, memory capacity and small screen) are some of the barriers for mobile learning adoption. In this paper, we combine mobile learning with OER and Cloud Computing Services to enhance supervisors' availability to their research students, who are in 'mobile-rich' but 'computer-poor ' learning settings typical for African universities.

Keywords: Mobile learning, Cloud Computing, Open Educational Resources

1. Introduction

A case study conducted by Muyinda, Lubega,& Lynch(2008) in Makerere University observed that the face-to-face collaboration between supervisors and research students was inadequate. The students were frustrated by the 'non-availability' of their supervisors. This includes limited face to face interactions that required student to physically meet their supervisors in the campus premises.

By the end of 2012, Africa had a 73% SIM penetration (Connections divided by total population) and is estimated to reach 97% by 2017(Kearney & GSMA, 2013). However, Computer Access is still very low in this region. A survey conducted by Calandro, Stork & Gillwald (2012) has revealed that in 10 African countries, only 30% of the population have access to computers, while twice as much (60%) have access to mobile phones .

Although, technical limitations and cost of using mobile phones hinder large scale adoption of mobile learning approaches(Isaacs, 2012), incorporating the use of open education resources(OER) and Cloud Computing services in mobile learning can be used to address these challenges.

This paper discusses how OER and Cloud Computing Services can be combined with mobile learning approaches to support research supervision processes in 'mobile-rich' but 'computer-poor' learning environments typical for African universities.

2. Related Work

2.1 Research Supervision Process

According to Hockey (1996), the supervision of students' project work is a complex social process that consists of strategies employed by supervisors for allowing research students to complete their research project successfully. Studies show this complexity to be further reinforced by the fact that the process itself is dynamic in nature. The strategies and tactics selected by supervisors and the way they are implemented depend on a number of factors within the research process that are fluid. There are three strategies which can be adopted (Spear, 2000). That is: i) *Strong Interaction*, which involves sharing of responsibilities in the running of an experiment, regular group meetings(usually after every

5 days) and continuous interaction (collaboration) between supervisor and student; ii) *Intermediate Interaction* is viewed as the most common strategy today, which requires the supervisor and student to agree on meeting frequency usually on weekly basis to discuss research progress; iii*) Weak Interaction* involves irregular and infrequent meetings with the supervisor, whose interval can be several months.

2.2 Mobile Learning

In recent years, there is increased attention in mobile learning by educators, companies, researchers and policy makers, which has resulted to variously definitions of mobile learning (Muyinda, Lubega, & Lynch, 2010).For the purpose of this study, we will adopt the definition by Parsons & Ryu(2006), which states that mobile learning is a form of electronic learning (E-learning) that use mobile devices.

The current forms of mobile learning can be classified into three categories based on their primary objectives(Mwendia & Buchem, 2014). These include: i) Context sensitive mobile learning, which aim at supporting learning by considering the learner's current context (such as activity, identity, and social relations); ii) Mixed modes of representation learning, which aims at improving the meaning of learning content by allowing learners to participate in a media-rich environment, for example, is using a mixture of video, audio and text to present the same learning content; and iii) Ambient learning, which aims at enabling anytime, anywhere and anyhow access to personalized and high quality E-learning material. This category is distinguished from other E-learning services by three main features: Firstly, Multi-modal Broadband Access enables learners to access different modes (e.g. text, audio and video clips) of online E-learning materials. Secondly, Content Management allows integration of existing knowledge catalogues and e-learning resources using meta-data language. Thirdly, Context Management enables capturing and using learners' context(e.g. personal profile, activities) to deliver relevant content (Paraskakis, 2005).

Although there is high proliferation of mobile phones in Africa, mobile learning is still in its infancy, partly because of limitations associated with mobile devices such as small screen, low storage capacity and communication costs(e.g. text messaging cost) (Isaacs, 2012).

2.3 Cloud Computing Services

Studies show that there are several definitions of Cloud Computing. In this paper, we will adopt the definition of Cloud Computing as a form of computing where largely scalable IT-enabled capabilities are provided as a service to external clients using Internet technologies(Plummer, Bittman, Austin, Cearley, & Smith, 2008). In the field of technology-enhanced learning(TEL), there are four categories of Cloud Computing Services that can be used to overcome certain limitations of mobile devices, server systems or desktop computers, especially to enhance accessibility and interoperability in technology-enhanced learning scenarios(Jansen, Bollen, Baloian, & Hoppe, 2013). These are:

- Cloud-based *Communication Services* can help to exchange information between learners in collaboration learning scenarios, for example, chat features in Facebook may be used to support group discussions.
- Cloud-based *Repository Services* can facilitate the integration of learning objects in the cloud, for example, storage services offered by Amazon Simple Storage Service (S3), Dropbox, Youtube, Instagram and Flickr.
- Cloud-based *Production Services* can facilitate the creation of new content and/or improve its quality, for instance, using web-based applications(e.g. 'Mindmeister') to create mind maps.
- Cloud-based *Processing Services* can help to process or analyze data, particularly large amount of data. A good example is the' Amazon Elastic Map and reduce' service that can be used to analyze huge data set with minimal effort.

However, more research is needed to investigate benefits of combining these services based on their potential functions for education usage, especially in mobile learning scenarios.

2.4 Open Educational Resources (OER)

According to Butcher (2011), open educational resources (OER) refers to any learning resources such as course materials and multimedia applications, which have been constructed for teaching and learning and are openly accessible for use by educators and learners, without requiring them to pay royalties or license fees. Cloud-based applications can be used to facilitate networking, sharing, communication, and the production and publishing of OER (Ally & Samaka, 2013). Some of the benefits for incorporating OER in mobile learning include:

- Improving quality of learning materials through peer review activities such as editing, adding and mixing (Park, 2013).
- Reducing communication cost by using free OER tools that supports free exchange of messages during collaboration without paying for access fees or licenses (UNESCO/COL, 2011).

3. Applications Scenario and Requirements Analysis

3.1 Scenario

According to Spear (2000), intermediate interaction is the most common strategy that is used to implement research supervision process in universities. We therefore focus on this strategy by discussing an example scenario, which was observed at KCA University in Kenya as a case study for this research.

Bachelor of Information Technology (B.Sc. IT) is one of the degree programs offered by KCA University, which enrolls about 50 students per semester. The Research project unit , is one of the course units that are offered in the program requiring students to do a computer related project of their own choice. The project is progressively evaluated by an allocated supervisor (usually a lecturer) from the start to the last stage of the project. At each stage of research progress, there are two main activities. Learning activity involves receiving guidance from the supervisor through provision of learning materials and collaboration. Evaluation activity involves submission of deliverable and oral presentation to the supervisor, who provides feedback (.i.e. marks, remarks) to the student. This process is progressively repeated until the final dissertation is submitted. In order to facilitate the project supervision process, mobile learning can be adopted in universities like KCA University.

3.2 Value-Adding Functions on Mobile Devices

Value-adding functions provided by mobile devices competes with those offered by printed materials. These functions promote the shift from traditional Distance Education Learning (DSL) that utilizes printed materials, towards mobile learning. The following table illustrates these functions.

Table 1: Value-adding functions of mobile phones compared to printed materials.

Mobile devices	Printed materials
Interactive support enables learners to communicate with others through feedback channels e.g. social media.	No collaboration (interaction) support due to the lack of feedback channels.
Multi-modal support allows access to dynamic content such as video and audio clips.	Can only support access to static content such as text and images.
Content in the same learning object can be updated dynamically through copy and paste features.	Content cannot be dynamically updated. It only be replaced with increased cost.

4. Proposed Learning Approach and System

The primary objective of ambient learning is to provide easy E-learning by supporting access to personalized and high quality content at anytime, anywhere and anyhow (Paraskakis, 2005). Among the three categories of mobile learning, this objective of ambient learning seem to be more appropriate for enhancing supervisors' availability to their research students. We therefore choose to adopt ambient learning as a form of mobile learning that can be used to support research supervision process in bachelor or master degree programs.

Ambient learning is described as combining requirements of learning paradigms and characteristics of ambient intelligence (e.g. embedded, context awareness, adaptation, anticipation) (Bick, Kummer, Pawlowski & Veith, 2007).Using this description, we propose a new form of ambient learning that consists of ambient intelligence characteristics and combines mixed modes representations learning with context sensitive learning, which use mobile devices, cloud-based services and OER for learning support. The distinguishing components of our proposed architecture are:

- The Embedded Mobile Application helps to overcome display limitations of mobile devices by supporting context awareness (i.e. capturing learner's context) and presenting personalized user interface for learners to choose preferred mode of representation (i.e. audio, video or text) (Bick, Kummer, Pawlowski & Veith, 2007).
- Cloud Computing Services help to overcome storage limitations of mobile devices (Jansen et al.2013- see above).
- The Content Manager searches and selects the most relevant online learning materials (videos, audios and text documents) from the cloud- based repositories by considering learners' context obtained through mobile application (Paraskakis, 2005).
- The Context Manager receives, evaluates and stores learners' context in the context database. Examples of context include learner's identity, education level, preferences and so on (ibid).
- Multimodal Mobile (MM) Broadband Access facilitates internet access to multiple modalities of representations such as audio, video and text modes at anytime, anywhere and anyhow using existing mobile broadband technologies such as wireless networks and internet enabled mobile phones (ibid).
- The Context Database stores learners' context (e.g. preferences, profile, learning stage, etc.) that is captured by mobile application. Therefore, the database is connected to the context manager.
- Open Educational Resources (OER) refers to freely available online learning materials (e.g. documents, video and audio clips) that are stored in Cloud-based Repositories (Butcher, 2011).

Figure 1 illustrates how these components are interconnected. It shows that learners can access personalized Cloud Computing Services (i.e Communication, OER repository and Production services) using mobile devices and adaptation components (i.e the context manager, the content manager and the context database) that run on local web server to ensure data confidentiality.

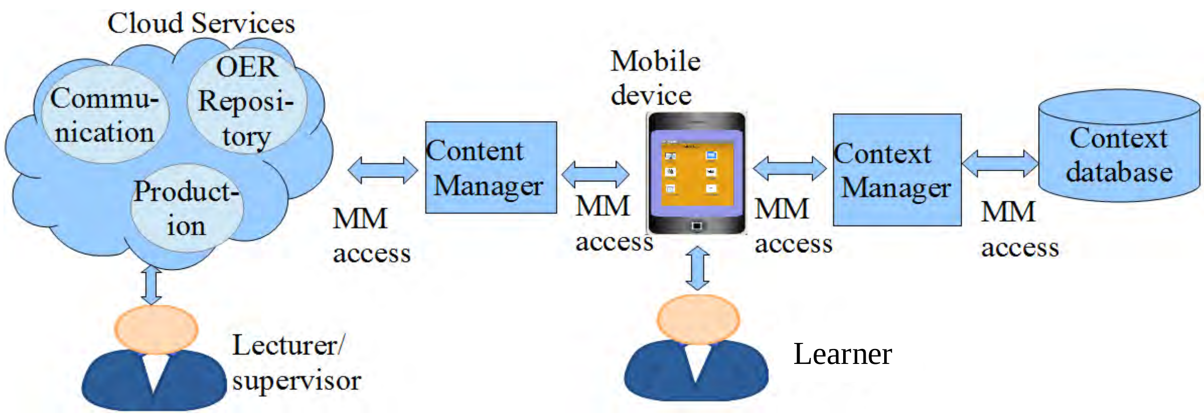

Figure1. Proposed system architecture.

5. Implementation

The effectiveness of the proposed learning approach needs to be evaluated before its adoption. To facilitate this, a prototype was developed during a stay of the first author at the University of Duisburg in Germany and later piloted at KCA University in Kenya starting from mid May 2014. The prototype consists of mobile application that runs on smart phones and a backend web server for hosting adaptation components (i.e. the context database, the context manager and the content manager). It also supports mobile access to Cloud Computing Services that are relevant to learners' individual context. Cloud-based applications connected to the prototype are: i) Google Docs for creating study guides and progress appraisals; ii) Facebook for collaboration support; and iii) Dropbox for managing OERs (i.e. storing, sharing, and deleting). Full implementation of the prototype is scheduled to start from January 2015 at KCA University and can be demonstrated using the following walk through example that includes screen captures of the prototype.

Example: Peter is a university student with a smart phone but has no personal computer at home. He has just registered for the research project unit through his phone and would like to start the learning process while at home during the weekend. Upon login, the mobile application his smart phone checks the context database and notices that no feedback has been posted so far. The application determines that Peter is a beginner and anticipates that next learning material is the proposal guide. The multi-modal access screen is then presented (as shown in Figure 2) so that Peter can choose his mode of access (e.g. video, text or audio). Peter chooses the audio mode, which will allow him to listen through headphones while he is cleaning the house. The application downloads MP3 files from OER repository (as shown in Figure 3) to allow the playing the audio file even when there is no internet connection (offline). After listening for 30 minutes, Peter decides to do a test for evaluating his proposal idea. Now he chooses the assessment option(as shown in Figure2). The application then presents the Progress Appraisal form, which contains diagnostics questions (for identifying knowledge gaps) and reflective questions (to help student evaluate himself) (as shown in Figure 4). Peter answers all the questions and submits them by pressing the submission button.

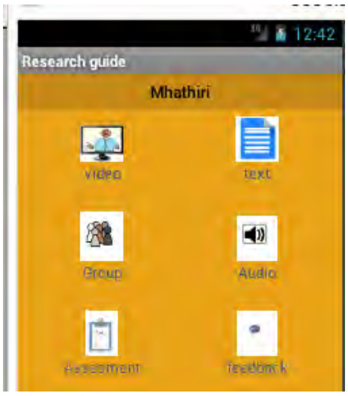

Figure 2. Main menu screen.

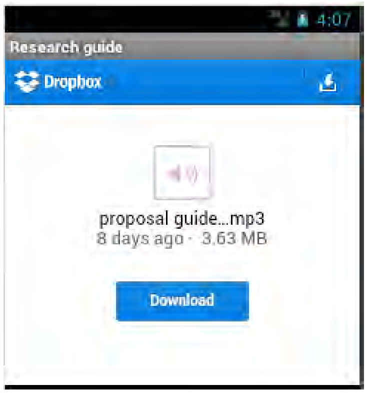

Figure 3. Stage 1 content.

Figure 4. Stage1 assessment.

Before closing the application, Peter presses the Group button(as shown in Figure 2), which displays Facebook page as shown in Figure5. He then writes a message to notify his supervisor that he has submitted stage1 progress appraisal. On receiving the notification, the supervisor uses his tablet to download the appraisal document in PDF format (as shown in Figure 6). He evaluates Peter's submitted work and posts feedback (i.e. marks and remarks) using his tablet as shown in Figure 7.

During the next learning session, Peter logs in and presses the Feedback button at the bottom of the Multi-modal access screen (as shown in Figure 2) .The mobile application searches for feedback posted by the supervisor in the database and presents it on the screen. This process continues for several days until Peter completes all the required learning stages.

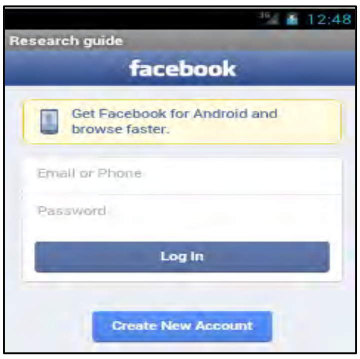

Figure 5:Facebook page

Figure 6: Downloading

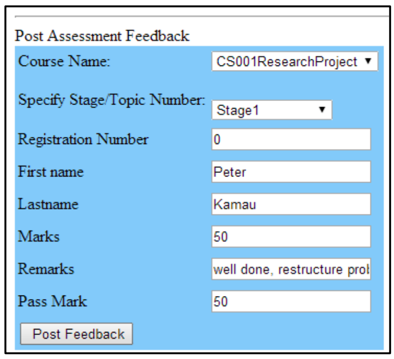

Figure 7: Posting feedback

6. Conclusions and Further Work

This paper discussed the proliferation of mobile phones and non-prevalence of computers in African universities. Mobile phones can be used to reach large proportion of learners but they are associated with limitations such as usage costs, small screen and limited storage capacity. Based on the digital status of African universities and the need to address limitations of mobile devices, a new learning approach has been proposed, which integrates mobile learning with open education resources (OER) and Cloud Computing services. In order to evaluate the approach, a mobile application has been developed to simulate how the new approach can be used for facilitating to access web based applications that offer Cloud Computing services. These include: Drop box, Google Docs and Facebook. Screen captures obtained from the simulator are included in this paper.

Further work is expected to focus on evaluating the effectiveness of the proposed approach. This can be done through conducting experiments in 'mobile-rich' but 'computer-poor' learning environments, especially concerning African universities. Additionally, there is need to explore other cloud-based applications that can support mobile learning scenarios.

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