Potential of Cost-Effective Mobile Learning in Resource and Bandwidth Constrained Environments

Michael P.J. Mahenge, Sokoine University of Agriculture, Centre for Information and Communication Technology, Tanzania

ABSTRACT

E-learning has received significant research attention over years in order to ensure reliability, availability and cost-effectiveness through Information and Communication Technologies (ICTs). The evolvement of mobile computing devices especially smartphones brings prospects in overcoming the inherent limitations of the Internet when accessing contents on web. Among the potential opportunity revealed includes the ability to work offline. Therefore, this study aims at analyzing the existing online and offline electronic-learning systems in order to explore the uniqueness, technical problems and opportunities in this field. Similarly, this study proposes synchronization and caching solution for cost-effective electronic-learning content delivery. The proposed approach synchronizes contents from the remote servers to local database in mobile computing devices for offline use. It therefore contributes to reliability, cost-effectiveness, timely and increase motivation in learning activities.

KEYWORDS

Cost-Effectiveness, Education, Electronic-Learning, Mobile Technology, Mobile, Learning, Offline, Online, Synchronization and Caching

INTRODUCTION

The advancement in Internet and mobile technologies brings a new paradigm of learning over the Internet (Lalita, 2011; Mshangi, 2013). In educational environment perspectives, learning system over the Internet has become popular and significant for supporting flexible and cost-effective learning activities especially for Higher Education Institutions (HEIs). Flexibility and accessibility are important factors that need to be considered when implementing electronic-learning solutions. According to Olson et al., (2011), flexibility refers to the standard measure of electronic-learning being learning for anyone, without restriction of time and space; that is, ability to learn anywhere and anytime while accessibility refers to the quality of the Internet connectivity.

Mobile phone technology evolves very rapidly offering new capabilities for supporting higher data transmission, storage, and multimedia (Cortez, 2012; Randell, 2013). Similarly, the rate of mobile phones adoption and access to Internet is generally growing rapidly thus bringing opportunities for reliability and availability of learning contents. Tanzania as an example; has been experiencing a growing trend towards mobile subscriptions. According to Tanzania Communication Regulatory Authority (2014) the trend of mobile phone subscriptions increased from 2, 963,737 in 2005 to 27, 986, 314 in March 2014 leading to a penetration rate to rise from 10% in 2005 to 63% in March 2014. Similarly, smartphone adoption has increased from 3% in 2010 to 9% in 2014 and thus projecting even more growth in coming years (TCRA, 2014). Furthermore, Mahenge and Sanga (2016) reported that
majority of students in HEIs of Tanzania own more than one mobile devices that can be used as a tool for facilitating access to education. Moreover, it has been reported that, already students are using their mobile phones for other activities like mobile banking, mobile money and social networking (Mtega et al., 2014; Sanga et al., 2010). Also, students use their mobile phones for learning activities via twitter, YouTube, Skype, Facebook and other social media. Therefore, this indicate possibility of implementing cost-effective mobile-learning in HEIs in Tanzania.

RELATED WORKS

Several previous studies proposed solutions for supporting both online and offline delivery of learning content. However, there are still considerable gaps to be addressed in order to improve efficiency of electronic-learning systems as well as availability of contents. The proposed solutions include; Trifonova et al., (2004, 2006) proposed Mobile ELDIT to support both online and offline content delivery. The proposed system can work offline by utilizing a caching proxy. However, the main shortcoming is a single point of failure due to the fact that all data came through the proxy server, if this server was compromised all users connected to such server are subjected to the risk of running out of service and information / data theft. Royyana et al., (2010) proposed offline web application and quiz synchronization for electronic-learning activities to support offline web application for Moodle task/assignment. One technical problem is the implementation of quiz point where the students with Wi-Fi capability phones can download the quizzes and store in their mobile phone memory. The Quiz engine performance depends upon the number of questions in the quiz as a result the time to display the first question is proportional to the number of questions in the quiz likewise memory requirement is directly proportional to the number of questions in the quiz. But also, the proposed system requires continuous Internet connection during downloading. Jordi et al., (2012) proposed Moodbile; the android application that supports both online and offline accessibility by storing offline contents in memory cache. However, synchronization functionality was not implemented. The proposed systems require continuous and reliable Internet connection during downloading of contents to memory cache as a result they favour learning environment with sufficient resources and reliable Internet connectivity.

Studies show that there is an exponential growth in bandwidth and decline in cost: specifically, the global bandwidth is expected to grow by 32% per year from 2010 to 2015 while the cost of bandwidth is expected to decline at 18% per year (Scott, 2012; Telegeograhy, 2012). It is also indicated that the new subsea cable construction and upgrading to existing systems have resulted in bandwidth price reduction worldwide. Although bandwidth prices have dropped globally, significant geographical differences in bandwidth usage cost remain. Lujara (2008) proposed Compact Disk Read Only Memory (CD-ROM) for offline delivery, however, tremendous growth of the amount of information and increased number of e-learning users do not match with the capacity of CD-ROM for supporting offline learning.

In the same vein, Bakari et al. (2010) commented that the learning and teaching processes in HEIs in Tanzanian are still performed mainly through the face-to-face mode. Adoption of modern ICTs such as computers, the Internet, mobile phones, IPAD, e-readers and personal digital assistants (PDAs) in education can significantly help to improve education service delivery together with use of other ICTs such as radio and television.

Therefore, employing the opportunities and capability of mobile computing devices for supporting offline e-learning would provide a cost-effective approach of learning content delivery and accessibility especially in HEIs.
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