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Developing Mobile Learning Contents Using MLOC

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Mobile learning (mlearning) is a field which uses mobile devices to access learning contents and conduct learning activities. Unfortunately, most of the institutions do not have learning contents that can be used in mobile devices. Developing mobile learning contents is difficult and therefore the technique of reusing online learning objects is usually employed. This paper proposes a structure 'Mobile Learning Objects Compilation Framework (MLOC)' that will have the capacity to search and retrieve Reusable Learning Objects (RLOs). The MLOC framework used was more efficient compared to other RLOs retrieved by other related mobile applications. This framework also confirms that MLOC can be used to process reusable learning objects for mobile devices. Evaluation is done by testing a prototype developed by using guidelines from the hybrid framework. The results indicate that the proposed framework can generate learning objects metadata and use them to evaluate and combine RLOs with acceptable accuracy of about 98%. The proposed framework can search and retrieve RLOs which are considerably more efficient compared to RLOs retrieved by other related mobile applications. This affirms that MLOC can be utilized to process RLOs for mobile phones.

Keywords: Reusable Learning Objects (RLOs); mobile learning (mlearning); mobile learner (mlearner)

I. INTRODUCTION

It is commonplace now to see people with a mobile device to the tune that one might feel not complete without it. In health, it has been used to support the monitoring of diabetic patients (Ahmad, Ayu, Abdullahi & Yakubu, 2017), used to measure and track the sleep patterns among children (A.S Al-Adwan, Samed, A. Al-Adwan, & Berger, 2018), used for the improvement of vaccination coverage among the rural and hard to reach areas in Bangladesh (Trifonova & Ronchetti, 2006) and also in educational settings (Briz-Ponce, Juanes-Méndez, García-Peñalvo, & Pereira, 2016; Katz, 2017). Many definitions are available of Mobile Learning (mlearning), but any form of learning that gives the learner(s) room to take advantage of the opportunities created by mobile technologies can be referred to as mlearning (A.S Al-Adwan *et al.*, 2018; Berger, 2018). mlearning is a field which uses mobile devices to access learning contents and conducts learning activities from virtually anywhere in the world as they become ubiquitous (Domek *et al.*, 2016). Unfortunately, difficulty in retrieving relevant information from mobile devices (such as lectures, videos, presentation, and simulations) have become a big challenge (Briz-Ponce *et al.*, 2016), and many lecturers take the option of using the Reusable Learning Objects (RLOs) found freely on the internet and customize them to fit their students' needs.

However, lecturers must create or search and assemble specific RLOs from the search engines which is not an easy task. To simplify this process, semantic web can be used to search, retrieve and assemble the RLOs into mobile learning contents. In the elearning context, the metadata are called

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Learning Objects Metadata (LOM). The Semantic web use special dictionaries known as ontologies to understand the metadata and links (Gavriushenko, Kankaanranta, & Neittaanmaki, 2015). Resources in the Web such as RLOs are stored with metadata in order to make them discoverable by semantic web agents. The study conducted here aimed to develop a framework to search and retrieve RLOs for mobile phones.

II. MOBILE LEARNING FRAMEWORKS

Many mlearning frameworks are being used in different countries. In 2002, the UK Learning and Skills Development Agency (LSDA), developed an mlearning system to access learning contents and services aimed at helping young adults aged 16 to 24 in Europe (Kukulska-Hulme, Sharples, Marcelo, Arnedillos´Anchez & Vavoula, 2011). In South Africa, mlearning has been used by University of South Africa (UNISA) to notify learners about different activities regarding their studies through Short Message Service (SMS) (Muyinda, 2010). The Open University of Malaysia (OUM) uses mobile device technologies to keep learners connected to the university, their peers, and their tutors (Lim, T. S. K., Mansor, F. & Norziati, M. 2011; Peng, Abas, Goolamally, Yusoff, & Singh, 2010).

Institutions have not taken fully advantages to access the learning contents by mobile devices because of the lack of learning materials that can be utilized by mobile devices. There also have been frameworks to implement mobile learning developed by various researchers. However, most of these frameworks were not integrated to the institutional learning system.

A. Effective Learning Contents for Mobile Devices

Effectiveness of learning contents is viewed differently by groups. The United States National Research Council produced a synthesis of research into educational effectiveness across ages and subject areas and concluded that effective learning is learner centred, knowledge centred, assessment centred, and community centred (Bransford, Brown, & Cocking, 2000; Richey, Klein, & Tracey, 2010). The study by Hsu, & Ching (2015), gives a review of models and frameworks for mobile devices and classify them in technological acceptance, pedagogies, evaluation and psychological construct (Hsu, & Ching, 2015). Also, Content, Pedagogy And Knowledge (PAK) model initially introduced by Shuman is renown to represent effective education and extended by technology in education model Technological Pedagogical Content Knowledge (TPACK) by other researchers to integrate technology in education (Robbins, Krebs, Rapoport, Jean-Louis, & Duncan, 2018). Also, effective learning can be achieved in three learning space: Individual, Collaborative and Situated (Richey, Klein, & Tracey, 2010). To be successful, a learner must use not only one learning space but a combination of all the learning space. Individual learning space involves the learners working on their own while using a set of materials and instructions prepared by the instructors (Sharples, Taylor, & Vavoula, 2005). In Collaborative learning, the learner attains new knowledge by engaging in a discussion and interaction with his friends and fellow students (Amel, Bruno, Freddy, & Claire, 2006; Dewitt & Siraj, 2011). And lastly, in situated learning the learner uses the environment and things surrounding him to construct new knowledge by relating what is happening in the environment with the learning contents and instruction provided to him (Amel, Bruno, Freddy, & Claire, 2006).

B. Limitations and Challenges of Mobile Devices in Deploying Effective Learning Contents

Studies conducted by Richey, Klein, & Tracey (2010), Rosenberg, & Koehler (2015) and Mai (2015), have grouped the challenges of mlearning to span between Technological, Pedagogical and some Social aspects. Also, research conducted by Khaddage, (2016), discusses the challenges of mlearning as pedagogical, technical, policy and research based. Also, Khan, Al-Shihi, Al-Khanjari, & Sarrab (2015), highlights the context as the social challenge in adopting mlearning and the cost of purchasing and running the devices is an economic challenge that must be considered. The mobile devices have limited processing power, limited display size as well as low transmission, storage and power (Uddin *et al.*, 2016). mlearning field is still young and therefore pedagogical factors have yet to be fully merged into mobile devices. It will then pose a huge challenge for the institutions to develop effective learning contents with all the pedagogical features in the mobile devices. Many people including the teachers perceive mobile devices as social gadgets and do not put much trust in contents available through mobile devices (Mai, 2015). On the other hand, it is expensive to pay for the mobile operational costs when accessing the RLOs using mobile. Eventually, learners would be bound to spend a lot of cash to buy powerful mobile devices to be able to participate in the mlearning activities (Ekanayake, Samarakoon & Wijesundera, 2015). These factors pose a big challenge to institution that want to take up on mobile learning.

III. THEORIES USED IN MOBILE LEARNING

There exist different theories that have been used to guide mobile learning (Trifonova & Ronchetti, 2006). The learning theories guiding the learning contents for mobile devices are discussed in the works of Brown (2005), Muyida (2010) and Peterson (2007). From these theories, we say that for the learning materials to be effective, it must fulfil the pedagogical perspective, be easy to use technologically and economically affordable for learning, which favours multimedia learning contents. Multimedia learning contents, however, vary in size and therefore to get the best out of multimedia contents, learning objects which are simple, short and domain specific ought to be used as described in the study (Yan, 2017).

IV. REUSABLE LEARNING OBJECTS

Learning Objects (LO), can be considered as the basic building blocks of any learning contents. They can constitute a whole topic, or they can be combined to form one topic (Amel, Bruno, Freddy, & Claire, 2006). LO, can be in many forms such as text, audio, visual, audio, video, or interactive component, etc. (Moreno, 2012). LO have been defined differently by many people but the concept is more important than the definition (Knowles, 2005). In this study we will adopt the definition of Wiley that says Learning object is "any digital resource that can be reused to support learning" (Wang, H.-C. & Hsu, C.-W. 2006).

The framework has the MLOC Engine, that is a similitude of a dynamic web application server that contains Inference engine, Random Forest Module, Crawler and web interfaces. These modules work together in the compilation process of RLO into the repository and retrieval by the user on their mobile phones.

The key feature of LO are their reusability such that they can be used and reused easily (Yen, Shih, Chao & Jin, 2010). RLOs can also be found on the internet in special databases called RLOs Repositories (Sharples, Taylor & Vavoula, 2005). Reusability is a process within product development lifecycle of software engineering which reduces the production time and resources by using an existing asset within a development of another product. In elearning, the digital learning contents are products of software engineering and can be reused in the production of other elearning contents. mlearning which uses mobile devices such as smartphones and tablets is a part and parcel of elearning and can re-use elearning contents (Muyinda, 2010). Some initiatives based on semantic web have been extended to use LOM to organize and assemble RLOs into effective learning contents (Mason, 2011). Good examples are the Sharable Content Object Reference Model (SCORM), A Learning Object Content Model (ALOCoM) and CISCO's Reusable Learning Object. SCORM has an advantage compared to the other initiative because it is independent of a learning system and therefore has been widely adopted throughout the whole world (Mason, 2011). However, SCORM still has shortcomings to cover modern education technologies including mlearning (Kavcic, 2011; Mudu, Schiatti, Rizzo, & Servetti, 2011). mlearning requires special kinds of RLOs which cannot be filtered in the current SCORM compatible systems. The RLOs need to be small, be effectively stored and accessed from the repository using mobile devices applications and contain enough metadata to make them easily reusable further. These features currently lack in SCORM compatible systems which in turn renders the SCORM based RLOs not to be effective in mlearning.

V. FINDINGS

Using the MLOC and comparing it with other similar systems, search terms were collected as topics from a research methodology course and stored in the database. Similar search terms were used in both applications and a paired t-test was used on the obtained results. The search results obtained were based on the Time, Source and Size of the RLOs, and it showed that from a sample size of 33, the MLOC framework produced different results as compared to the YouTube application. This was evidenced as the mean running time for the YouTube application were 14.50s as compared to 4.96s of the MLOC application.

In comparing the means of the two variables in t-test we obtained a rejection region R:|z|>1.96 which was less than the calculated t-test value of 13.813. The difference of means between YouTube application and MLOC application is 9.54 minutes, implying that, by using MLOC application, the average length of the retrieved RLOs are about 65.79% smaller compared to YouTube application which indicated that MLOC can retrieve smaller RLOs which are more suited to be used in mobile devices compared to native YouTube application.

Table 1. Random Forest Results based on Optimum Training Features for RLOs Evaluation

Evaluation Criteria Results	
Precision	0.986
Recall	0.986
F-Measure	0.986
ROC	0.996
MAE	0.0275

The results summarized in Table 1 above shows that the overall accuracy is 0.986 (98.6%) for Random Forest based on Optimum training features for evaluating RLOs. These results were then used to compare MLOC with other similar systems to evaluate the performance of MLOC. The results obtained show that MLOC stand to achieve better results compared to other similar mechanisms of evaluating RLOs from search results as shown in Table 2 below.

Table 2. MLOC Comparison with RLOs evaluation systems

Research Work	Personalized Learning Objects Recommendation Based on the semantic aware discovery and the learner preference pattern (Wang et al., 2007)	Ranking metrics and search guidance for learning object repository (Yen et ai., 2010)	MLOC
Precision	Not given	86.90%	98.6%
Recall	Not given	86.90%	98.6%
F-Measure	Not given	0.9109	0.986
MAE	Value oscillates between 0.5 and 1	Not given	0.0275

The whole process of retrieving the RLOs from online repositories contains many processes, each of which presents difficulties to the users. First, lecturers must search for RLOs from different packages from the internet using search retrieval tools such as Google (Uden, 2007). Then after, since not all RLOs can be used in mobile devices, the lecturers must evaluate if the RLOs are usable in mobile devices, download the RLOs and store it in the local repository. After that the RLOs must be integrated with other RLOs based on the learning templates to form complete effective learning contents. Since all these tasks are difficult, most of the lecturers fail to find the RLOs suitable for mobile devices using search tools.

VI. CONTRIBUTIONS

The major contribution of this research is to create the framework to reuse learning objects in mobile devices from online repositories. This research therefore looks to generate metadata from the search engine and repositories that houses RLOs to use them for RLOs evaluation. We also introduced a method of evaluation and assembling RLOs for mobile devices using Semantic web and Random forest. The research introduces the alternate mechanism of getting the best RLOs that can be used in mobile devices. Semantic Web is used to define and connect the relationship between the

RLOs and their templates and the Random Forests algorithm ensures the speed of the semantic web is enough to produce timely results. We also improved the semantic method of evaluating RLOs using Random Forest classification so that the RLOs are easily connected in heterogeneous systems. As semantic web uses transitive rules in classifying RLOs, which involve many steps and may delay the classification process. Thus, Random Forest was used to classify the RLOs in place of transitive rules. Hence, the research will increase the speed of Semantic web in general.

VII. CONCLUSIONS

A Mobile Learning Objects Compilation (MLOC) framework which is a hybrid framework of random forest and semantic web is proposed by this research to address the challenges of generating effective RLOs for m-learning using semantic web. The hybrid framework included a method to generate RLOs metadata from repositories, use those metadata to evaluate the RLOs, assemble related RLOs to form larger RLOs and expose these learning contents to other outside systems through web services so that mobile applications can access the RLOs easily. This is achieved by first, introducing a method to generate learning metadata from public search results based on learning theories. Second, establish the semantic methods to evaluate the RLOs and assemble RLOs into complete learning units in a repository that can be accessed by mobile devices. And lastly enhance the semantic evaluation of RLOs by using Random Forest. This framework will increase access to mobile learning contents and their metadata as well as improve inferencing capabilities of Semantic Web. Evaluation was done by testing the prototype developed by using guidelines from the hybrid framework. The results indicate that the proposed framework can generate learning objects metadata and use them to evaluate and combine RLOs with acceptable accuracy of about 98%. The proposed framework is also able to search and retrieve RLOs which are much more efficient compared to RLOs retrieved by other related mobile apps which in turn confirms that MLOC can be used to process reusable learning objects for mobile devices.

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