

Implementing Learning Objects Repositories for Mobile Devices

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Abstract. The m-learning (mobile learning) is propounding as an alternative and as a support method for both traditional and electronic learning (e-learning). Even though, in this new scenario there is a lack consensus regarding norms, rules, policies and techniques to be applied (from both technological and educational points of view). This fact is being aggravated by the actual heterogeneous kinds of devices and technologies available. The aim of this paper is to define an architecture that fully supports the m-Learning process. We are going to empathize in the design of the learning object repository (the learning object warehouse), attempting that both, the learning objects and the repository, were independent and able to be accessed from a multiple bunch of devices, independently of its individual and special features. To achieve our objectives, previously we are going to review the state of the art of m-learning. After that, the architecture that solves the most common situations, including the challenges proposed, is established. Finally an implementation of the architecture is exhibited for discussing about the results.

Key Words. m-Learning, Learning Object, Repository, Mobile Device.

1 Introduction

With the new “anytime, anywhere computing” paradigm (ubiquitous computing), a shift from “electronic” to “mobile” services has begun. So as e-commerce is extended to m-commerce, e-learning now includes m-learning [1]. In the field of teaching and learning, the benefits of this new mobility are expected to be thrown back in a more efficient instruction and in an improvement of the learning outcome. In this framework it is crucial to define an architecture for supporting the whole training process, including the repository where the learning objects are stored in order to be delivered to the mobile devices. This paper describes the process of creating and implementing such architecture. In the section 2 we make a description m-learning reviewing the state of the art., in section 3, the architecture for supporting the teach-

ing and learning process within mobile devices is defined, and finally, in section 4 we show an implementation of it.

2 m-Learning

Before giving a definition of m-learning, we are going to introduce the ‘mobile-education’ concept. Mobile education is defined as “any service or facility that supplies a learner with general electronic information and educational content that aids in the acquisition of knowledge regardless of location and time” [1].

Going on with the definition given by Lehner and Nösekabel in [1], it covers a variety of aspects that should be studied. First, any service which fits this definition can be part of m-education. Second, the definition focuses on electronic information and content. Note that it is not necessary that the service itself provides learning content –services that reduce the learners need for secondary information (like due dates, deadlines, dates for additional lectures, the menu of the cafeteria and even the schedules for public transport) help the education by reducing time and effort normally spent on acquiring this kind of knowledge.

2.1 Definition

Multiple definitions of the term “m-learning” have been done covering a wide variety of aspects. Some definitions identify the m-learning as mere evolution of e-learning, while others define it as an independent trend that is originated in the ubiquitous nature of the actual communication systems, and identify m-learning as ‘location-independent and situation-independent’ [2].

Web-based learning, embraced by many educators, extends study beyond physical classrooms. M-learning -learning with mobile devices - promises continued extension towards “anywhere, anytime” learning [3].

McLean in [4] considers ‘m-learning’ as a term coined to cover a wide range of issues opened up by the convergence of new mobile technologies, wireless infrastructure and e-learning developments. As with any emerging paradigm, there are many attempts to define its essence. He quotes three of these definitions in order to capture the common threads inherent in the term m-learning: (1) “M-Learning is the intersection of mobile computing and e-learning: accessible resources wherever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment. E-Learning independent of location, time or space.” [5], (2) “A new m-learning architecture will support creation, brokerage, delivery and tracking of learning and information contents, using ambient intelligence, location-dependence, personalisation, multi-media, instant messaging (text, video) and distributed databases” [6], y (3) “Three ways learning can be considered mobile “learning” is mobile in terms of space; it is mobile in different areas of life; it is mobile with respect of time” [7]

After presenting all these definitions, we can abstract three aspects recurrent in all of them: (1) The m-learning to be mobile should be able to be accomplished from any

place, (2) the m-learning to be a mobile should be able to be realized at any hour, and (3), is needed any kind of device (small and easy to carry) that allows to complete the process.

2.2 m-learning Usage

It appears as argument in many texts, which discuss about m-learning, that the mobile/electronic education should not attempt to replace traditional education with tutors and instructors, but support both students and teachers by providing services that facilitate teaching, learning and related administrative tasks. The basic approach is integrative, combining variety of (mobile and non-mobile) devices by means of another variety of technologies of transmission (wired or wireless) [1].

Another argument in favour of this hypothesis is proposed by Houser et al in [3], where after analyzing some successful m-learning projects, they conclude that all the examined projects use the mobile devices as a part of educational mixed programs (b-learning or “blended learning”) that can combine education in attendance, via web and mobile components.

Shepherd in [8] raises three possible uses for m-learning: (1) One idea is to use m-learning to help in the preparatory phase, before the learning begins, through the use of diagnostics. Diagnosis in learning includes pre-tests, learning-style tests, attitudinal surveys and the gathering of pre-requisite data about the learner's experience, job, qualification and so on. This data is useful as it can prevent wasteful time on courses, where the learner already knows the material. It also allows you to shape the learning experience towards that particular learner. (2) Another possibility propose the m-learning as a method that supports students (in different levels of the educational system) in preparing his examinations and in reviewing his knowledge. And (3), the most interesting prospects for m-learning (as Shepherd considers) are in the follow-up to learning, the application to real-world problems. The best way of understanding what we want to say with this definition is to present a scenario: “An engineer is called out on site to fix a problem with a printer. The engineer has never been trained on that printer. When he or she arrives at the client site, the engineer takes out his or her PDA and finds the course that shows step by step, through the use of a 3D animated diagram, how to troubleshoot this printer and how to replace each part”. With the use of these methods, users can learn continuously, when they need it, and applying the knowledge acquired to the resolution of problems.

Another issue that must be considered is the kind of contents distributed by means of the m-learning. Due to the special characteristics of the mobile devices used in this type of initiatives, these terminals are used as conduit to distribute auto-evaluation tools and study guidelines, enabling in some cases, ways of feedback between educators and pupils, as Wuthrich et al indicates in [9]. These authors emphasize the essential role that tests and questions plays in the acquisition of knowledge, and consider that mobile devices are specially suitable to solve questionnaires, considering the special circumstances of mobility that students have to face nowadays.

3 Architecture for Implementing a m-Learning Based Solution

The main aim to achieve is to allow that users, with his mobile devices, were able to accede to educational contents across Internet independently of his location. Figure 1 shows the proposed architecture.

3.1 Architecture Components

Later there is a description of each of the components that composes the proposed architecture.

Mobile Device. Any physical device (hardware) of those ones that are considered valid for the m-learning. The main types of mobile devices are: PDAs, mobile telephones and smartphones, though also tablet PCs and laptop computers can be considered.

mLMS. Mobile Learning Management System (sometimes called wireless LMS). It is the main component. It is entrusted to manage all the aspects related with courses and participants. The basic functionality must cover the capability to serve the contents required by learners. In [6], the features and functionalities of a mLMS are determined, these features and functionalities can be summarized in the following points:

- *As for the management:* (1) Allow learners to register from their mobile devices, (2) Send to the pupils mobile devices information about the registration, about the courses and about the system login and passwords. (3) Store all the information about the learners in any database system.
- *As for the course contents:* (1) Store the contents of all the courses of the system, (2) Allow the pupils to accede to the contents from their mobile devices. (3) Create a comfortable learning experience for the learners who study from their mobile devices.
- *As for the assessment:* (1) Provide evaluation and tracking activities to the learners who accede from mobile devices, (2) Offer immediate response and instantaneous feedback on the tasks that the pupils are accomplishing from their devices. (3) Learner scores must be stored together with the other information about the own pupils.
- *As for the communication:* The mLMS must provide communication by means of voice, SMS and MMS to the students who accede from their mobile devices. The system should allow students to communicate among them, and with tutors and managers.

Learning Objects Repository. Depot where the learning objects (LO's) and the additional objects, required to deliver contents to learners, are stored. The mLMS must access the repository to recover the educational objects asked by the pupils in order to serve them properly; equally it must allow teachers and/or tutors to create, modify, accede and delete the learning objects in a suitable way. There must be feature for grouping learning objects in upper level structures (modules, courses and

lessons) to be able to shape major units of learning. Those bigger units of content make possible the reutilization of learning objects, since they can constitute several of these units. These lessons, courses and modules can be stored in the own repository (centralizing the whole system) or externally (distributing the different elements of the system).

Learning Object. Each of the meaningful components stored in the repository that is suitable for being re-used in different courses.

Asset. Each physical or logical component (files and other resources) that constitute a learning object.

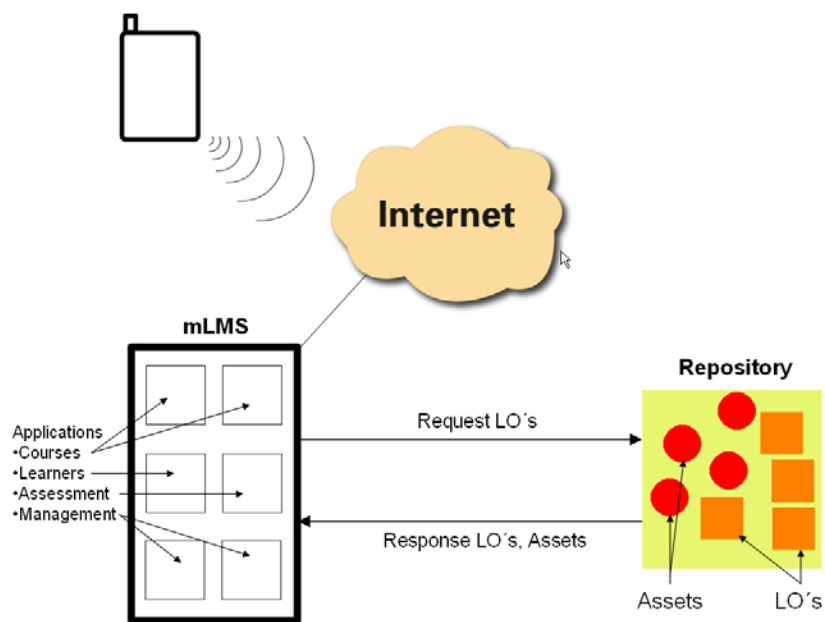


Fig. 1. Proposed Architecture.

3.2 Learning Objects Repository Definition

The definition of the repository of educational objects depends on the contents that are going to be delivered to learners. We have defined a repository that stores the common contents used in m-learning, that are explained in [9]. These common contents include study guidelines and summaries, and auto-evaluation tests. Figure 2 shows the structure of the repository and the components that constitute it.

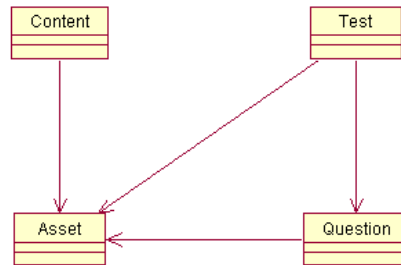


Fig. 2. Structure of the Learning Object Repository

- **Asset.** All the elements that constitute the learning objects and that are physically and/or logically indivisible. They are capable of being re-used in several contents and/or questions, and they give ‘vision of aggregation’ of the contents in strict sense, because these contents are compounded of several assets.
- **Content.** Those meaningful and context independent elements that constitute the educational materials, and that are suitable for being re-used. Contents concern those materials that form the theoretical and practical set of elements that would compose the courses (the evaluation components are not included). Every content is formed by a set of assets (one or more).
- **Question.** Any element included in a test or questionnaire. Different types of questions must be considered including the most classic and most recent methods. Equally, and taking into account that the questions need answers, there must be considered the most suitable methods of interaction for every type of mobile device, and scorn those types of questions that reduce the level of usability of the system, for example those who require long text inputs. Different kinds of questions can be used, including the following: (1) Multiple choice questions, (2) ‘fill the gap’ questions, (3) open answer questions, (4) ‘matching’ questions, y (5) ‘drag and drop’ questions.
- **Test.** They are mere containers of questions. They contain the information that describes the sequence of questions that compose the test, including links to those questions.

4 Architecture Implementation

In order to study the viability and functionality of the proposed architecture, an implementation was carried out.

During the implementation process, the following decisions were taken: (1) Bind the study to a concrete device, PDAs, and (2) use the technologies and standards that were commonly used in web developments and e-learning platforms.

As for the standards, the final system is compliant with SCORM [10, 11] and QTI [12, 13] specifications. And as for the technologies, Flash was used to develop the client application and XML was used to send and store all the information (including learning objects)

Figure 3 shows the result when the application is running on a PDA.

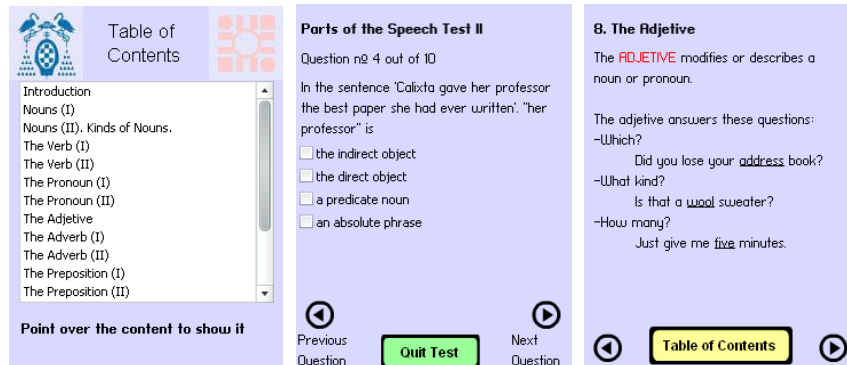


Fig. 3. Final Application Running on a PDA

5 Conclusions and Future Work

M-learning appears as an available education system when it is used for supporting traditional systems [1, 3], it is habitually used by the learners to accede to support contents and to auto-evaluation tests of previously acquired knowledge [9]. In this study we have focused on defining and implementing a valid architecture for the accomplishment of m-learning based solutions, considering the contents and applications that are more commonly used in this kind of initiatives. We have paid special attention to the repository of learning objects, since it is inside it where there is stored the knowledge that will be delivered.

Finally, we can outline that the current technology state allows us to lead to end successfully this kind of developments and to implement the architecture proposed, hereby being able to analyze m-learning capabilities and possibilities, as well as to analyze its deficiencies and possible improvements

Future work an investigation lines include: (1) Analyze the issues that raise the inclusion and use of metadata in the learning objects delivered to mobile devices, (2) study the feasibility of using web services based distributed learning objects repositories according to IMS specification [14], and (3) research the feasibility of personalizing and adapting the m-learning applications and contents to the knowledge and preferences of the learners, regarding the capabilities of the mobile devices.

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