Mobile Learning and SCORM

Case Study for Educational Contents Reuse

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Abstract

There are many educational resources on the Internet. Learning objects are conceived as a way of resusing these resources. The Sharable Content Object Reference Model (SCORM) is a common model for learning objects that makes the reuse of educational contents among different systems. The objective of this paper was to show how it is possible to view and access from a mobile device educational content formatted as a learning object and packaged under the SCORM model. This is very useful in mobile learning (m-learning), where it is common that the materials created are very specific to a particular learning environment and unable to be reused in other platforms compared to those for which they were created. The application created for this purpose, named SCORMmobile, has been used at present in real environments by several e-learning businesses.

Keywords

SCORM; Learning Objects; Reuse; Mobile Learning

Introduction

Learning objects are a key concept in the reuse of educational resources. For this, a learning object includes not only educational content, but also metadata descriptions that describe the object and make its use and location easier.

Different models have been proposed in order to achieve this purpose. Sharable Content Object Reference Model (SCORM) is a common model for learning objects, whose main advantage is to make the reuse of educational contents between different systems easy (learning object repositories and e-learning platforms, for example).

Currently, SCORM is a 'de facto' standard supported by major manufacturers and consumers of e-learning solutions and supported by the leading learning platforms.

Learning objects and their associated standards, as SCORM, allow e-learning to achieve a common methodology to ensure the accessibility, interoperability, durability and reuse of materials in digital format.

At present, e-learning evolves into new platforms where it is possible to learn using the Communication and Information Technologies, from not only personal computers, but also mobile devices. This paradigm is called m-learning.

The m-learning concept can be considered as an evolution of e-learning that allows user to take advantage of mobile technology to support the learning process.

The Mobile phone is currently a very common device; a personal device (people do not share their phone with others) and can be carried all time. For many mobile applications, a permanent Internet connection is not mandatory in order for it to work. For all these reasons, the mobile phone is an ideal tool to be used at any time, and also to learn and make better use of our time.

In this paper, the concepts of the SCORM model and mobile learning will be related in order to promote the use and reuse of the educational contents on mobile devices.

Currently, content in m-learning is tailor made and the educational resources that already exist are not reused. Our proposal tries to give a solution to this problem. In the first section after the Introduction, the problem analysis will be contextualized. On one hand concerns the main trends in m-learning research, on the other hand the fundamentals of the SCORM model. In the next after this section, the SCORMmobile project will be described, which is the case study that uses the SCORM model in an m-learning context. We will present the idea of the project with a particular focus on the second version of the application for the Android platform. The paper finishes with conclusions and future work.

State of the Art

In this paper, two concepts were linked, m-learning and the SCORM model, for learning object reuse. Therefore both subjects were explored.

First of all, the current trends in m-learning will be examined and then the foundations of the Sharable Content Object Reference Model.

Research Trends in M-learning

The m-learning concept can be considered as an evolution of e-learning that allows the user to take advantage of mobile technologies to support the learning process.

The number of users accessing teaching platforms using mobile devices is increasing every day; so does the number of utilities for these platforms. But there are also many features that should be improved to facilitate this task. To this end, there are different advanced research trends in this area. The most interesting research trends will be discussed.

One of those research lines focuses on the analysis of issues involving education and teaching methods through mobile environments. A project which aims to develop innovative teaching methods using the mobile can be found in the (Herrington et al., 2009) e-book.

Due to the limitations and special features of these devices, another trend is the adaptation of contents in order to make them accessible from mobile devices. The idea is to translate multimedia content, images, web,... to a format that can be viewed on mobile devices. There are some applications in the market that allow different types of format conversion.

The integration of mobility systems in learning management systems (LMS) is another research issue. This line is mainly oriented to include mobility features in online learning platforms. Moodle is one of the most extended learning platforms. There are several studies of this type with Moodle, but most of them are in process or not released:

- MLE (MLE, 2013)
- mTouch for iPhone (MoodleTouch, 2013) as a native application for Moodle
- MOMO (Mobile Moodle, 2013), developed specifically for Moodle although it requires downloading a client for mobile devices and does not work in version 2.0 of Moodle.
- Moodle Mobile apps for Android and iOS which was released in May 2013 (http://docs. moodle.org/25/en/Moodle_Mobile_app).

However, these adaptations are always partial and specific of a particular learning platform (Moodle in this case). In addition, some of them are not operational or are not accessible.

Finally, another important line of research that would fit the aim of this paper, is oriented to allow learning content that follows e-learning standards to be viewed from a mobile device. This line has a lot of development potential in the future.

Currently, the most important initiative in this area is Pocket SCORM Runtime Environment (Nigel et al., 2004) that allows the adaptaptation of SCORM contents to mobile. However, the functionality of this project in relation to the SCORM standard has become somewhat outdated and limited. Another disadvantage is that it does not support the sequentiation and timing characteristic of the new version of the standard

Other authors proposed using an intermediate layer (framework) to adapt the SCORM object to use it in mobile devices like in (Drire et al., 2009).

Our proposal is also going on this last line, which is the less explored with the aim to achieve displaying the contents of a SCORM in mobile phones.

SCORM

SCORM model, a 'de facto' standard in e-learning is a specification of ADL (Advanced Distributed Learning) (ADL, 2009) (ADL SCORM, 2013), with the main objective to share educational content between different systems to facilitate the reuse of this content.

SCORM is composed by three models:

- Aggregation Model (CAM) which defines how the educational content may be packaged in a .zip file. In this way, the content can be transferred among different systems.
- Run Time Environment which defines the communication between the e-learning platform (LMS-Learning Management Systems) and the host where the educational content is stored.
- Sequencing and Navigation Model (SCORM SN): This model is very important in the new 2004 version (ADL, 2009). It consists of a set of rules that specifies the order in which learner should acquire the knowledge.

In our proposal, it is necessary to study in detail the Aggregation model.

From the point of view of this model, the content is packaged in a .zip file which contains a special file: a XML file which contains the information about the structure (organizations) of the objects and their resources. Apart from this, the objects and their

components could also contain metadata about themselves. These metadata are described using another e-learning standard, LOM (Learning Object Metadata) data model (LOM, 2013).

LOM defines nine categories to describe a Learning Object. These categories describe, for example, general information about the object: technical requirements, copyrights, pedagogical characteristics to use it…

Any LMS who wants to use the SCORM object will have to interpret the content and structure of this XML file.

The methodology to manage this file is described in the next section.

Methodology to access SCORM Objects from Mobile Devices

Currently, most of the educational contents for m-learning are tailor made. For these reasons, on one hand existing education contents will not be reusable. On the other hand educational contents especially designed for m-learning will not be able to be used or reused in others environments.

Since elearning is not a new concept, and teachers have been using it for many years, there are many educational contents in different learning object repositories (LOR) or in Learning Management Systems (LMS). SCORM enables content sharing across platforms where content is packaged using the SCORM model, and this content could be interpreted an accessed from all the LMSs and LORs that support this model.

Therefore, where a mobile phone was able to interpret a SCORM object, all the contents packaged with SCORM could be accessible from mobile and used as resources for m-learning.

SCORMmobile (SCORMmobile, 2013) is the application which gives the answer to this question. The objective of this work is to view and access educational content in the form of a learning object and packaged under the SCORM model, from a mobile device. This would be very useful from the point of view of m-learning, where it is common that the existing materials are very specific to a particular technology and unable to be reused in other environments than those for which they were created.

SCORMmobile shows the content of a SCORM object in a mobile phone. To achieve this purpose, it is necessary to not only extract the resources of the

educational content, but also find out the structure and organization of this content.

SCORMmobile will show on the screen of the mobile the structure of the resources of this object. At this moment, the user will have only to select the resources of the SCORM object visualized on his mobile.

To reach this objective internally, the software component has to carry out several steps which are described in the next section.

Steps to Manage a SCORM Object from a Mobile Device

In order to view a SCORM object on a mobile device, firstly the user has to download the object on his device from a LMS (such as Moodle or any other), or from a repository of learning objects such as ARIADNE (ARIADNE, 2013) or MERLOT (MERLOT, 2013). It is also possible that the user packs educational content in the SCORM format before downloading the object on his/her device, using some specific tool such as eXelearning (eXlearning, 2013) or the Reload Editor (Reload, 2013). That is, on one hand there are a lot of contents already packed in SCORM format and on the other hand, in case the content is not in SCORM format yet, it is also possible to pack it in an easy way. Therefore you can reuse for learning, any educational content new or that already exists, packing it in SCORM format. Once the user already has the content in SCORM format, he/she can download this content on his mobile to process it. Accessing a SCORM object using a mobile phone means that it is possible to view its content and navigate inside its structure.

It is necessary to be connected to the Internet to download the object onto the device, only the first time you want to access the object, but once the object is on the mobile device, the user does not need an Internet connection any more. This is an important advantage because you can continue accessing the object even in areas where mobile data or Wifi connectivity is unavailable or expensive. A native application was implemented to process the content of the learning object already stored in our mobile.

Once the SCORM object has been downloaded on the mobile, it appears as a packaged file in zip format. Therefore the first task will be to unpack the zip file.

When the file is unpacked, a special XML file, named "imsmanifest.xml", is obtained. There are other files, but this one is special because it contains all the information about the organization and resources of

the object. Therefore this XML file must be explored, in order to find the structure of the object.

The content of the object can be organized in different ways from a pedagogical point of view. Therefore, the same object could have different organizations to view its educational resources. Each organization could have different items and each item could have other nested items or specific content associated with a resource.

Thus, the object is structured in "organizations". Each "organization" has "items". Each item can have other items or an associated "resource". If the item corresponds to a resource, the content of this resource will be visualized on the mobile when the item is selected; otherwise, the nested items will be visualized. In this last case, a tree view is used to show the structure of the item (implemented as a list view in our mobile application). This is the same format as the one used to show this type of information in an LMS and it allows navigating through the structure of the object.

Once the user has selected a resource of the learning object from the tree, its content is shown on the device screen. SCORMmobile allows visualizing different types of contents: Office documents, Web or PDF contents, for example.

Figure 1 shows part of the content of the "imsmanifest.xml" of a SCORM object. The object presents a basic course of English for Spanish people. It has two main organizations "Paso a Paso" (Step by Step), for learning the English concepts, and "Teoría y

Práctica" (Theory and Practice), to practice them after learning the concepts. Inside each organization, there are different possibilities (items), for example the item "Conceptos Básicos" (Fundamental Concepts); and the concepts to learn (which correspond to the "resources" associated to the "items"). For example, the file "Basic_concepts.ppt" will be the resource associated to the item "Conceptos Básicos" because the attribute "identifierref" of the label "<item>" of the item named "Conceptos básicos" has the same value, `RES-3143193A4D34EC00D07D4919C98690C3`, as the attribute "identifier" of the label "<resource>" whose "href" attribute is the file "Basic_conceps.ppt"

Figure 2 shows the first level of the tree associated to the same learning object . In this example, the objective of the SCORM object, as we have just said, is a simple English course . The tree presents the structure of the object. The example shows that the object has two organizations. The learning content can be organized "Paso a Paso" or "Teoría y Práctica". Inside each organization there are different items. Figure 3 shows the items of the second level, nested in the organization "Paso a Paso", in this case: "Lo Fundamental" (Basic concepts), "Alimentos" (Food), "Deportes" (Sports) and "Repaso" (Review). The user has just to select the item who wants to open. In this example, user has selected "Alimentos" and obtained again its nested items (Figure 4): "Vocabulario comidas" (Vocabulary about Food) and "Ejercicio" (Exercise). Finally, the user selected the item "Vocabulario de Alimentos" and Figure 5 shows the content of this selected resource of the SCORM object which are words about some types of food.

```
<organizations default="ORG-896BE6504A9BB9CB24735D60F90B0D99">
    <organization identifier="ORG-896BE6504A9BB9CB24735D60F90B0D99"
structure="hierarchical">
      <title>Paso a Paso</title>
      <item identifier="ITEM-80FBA8B29953D243347195F1BD9B7F7A"
isvisible="true">
        <title>Lo fundamental</title>
        <item identifier="ITEM-1E6EF66074C02580A1B9C08B03EA88BB"
identifierref="RES-3143193A4D34EC00D07D4919C98690C3" isvisible="true">
          <title>Conceptos Básicos</title>
        </item>
        <item identifier="ITEM-E0910022BD4DCBB197E522D15302BF83"
identifierref="RES-B83D0358B15B6B0020B31A2B31DBFCF4" isvisible="true">
          <title>Vida Diaria</title>
        </item>
…
      <resource identifier="RES-3143193A4D34EC00D07D4919C98690C3"
adlcp:scormType="asset" type="webcontent"
href="RECURSOS/Basic_concepts.ppt">
      <file href="RECURSOS/Basic_concepts.ppt" />
    </resource>
```

Organization "Paso a Paso"

Item: "Lo Fundamental" of organization "Paso a Paso"

Item: "Conceptos básicos" of organization "Paso a Paso"

Resource associated to item "Conceptos básicos "Paso"

FIG. 1 EXAMPLE OF XML STRUCTURE OF A SCORM OBJECT …

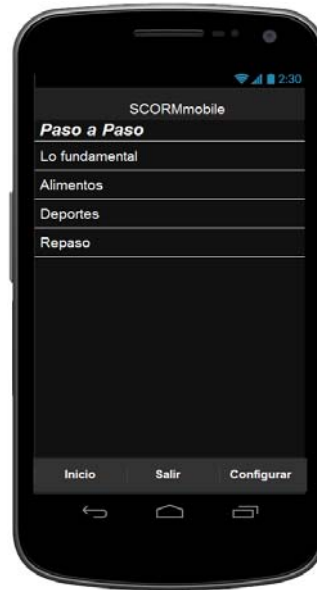FIG. 2 STRUCTURE OF A SCORM OBJECT ON AN ANDROID MOBILE PHONE

FIG. 3 STRUCTURE (NESTED ITEMS) OF THE FIRST ORGANIZATION: "PASO A PASO"
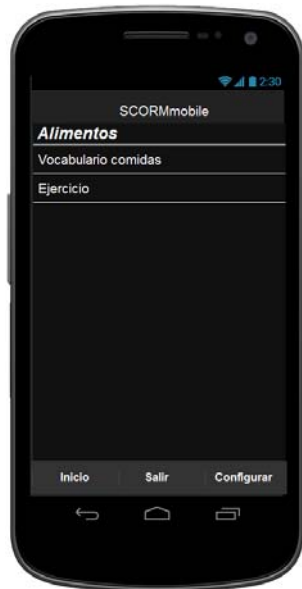

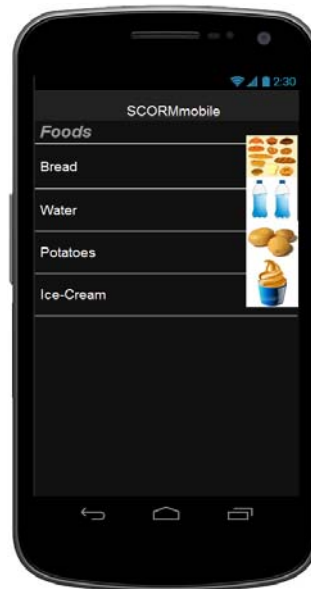FIG. 4 STRUCTURE (NESTED ITEMS) OF THE ITEM "ALIMENTOS" IN THE FIRST LEVEL

FIG. 5 CONTENT OF THE SELECTED ITEM "VOCABULARIO DE COMIDAS"

Results

SCORMmobile was developed in its first version as a native application for the Windows mobile platform (Fermoso and Pedrero, 2011). When this first version appeared, an elearning company bought the software application under a software license agreement and at present, anothers companies of the same sector use it in their business process.

The company developes their own learning contents and then pack them in SCORM format. The main business clients (students) are people who work and for this reason they do not have much time to learn and they need to do it at any moment and place

whenever they can. Moreover, it is also possible that the students live away from Spain, mainly in Italy and Iberoamérica, where these enterprises have other educational centers. But most of these students have a mobile device. Therefore, the enterprise can put their SCORM objects in its Web server and the students can access and learn through them, once they have downloaded the SCORM objects in their mobiles.

The application was successfully checked, but the problem was the limitation of the mobile platform because the application was only for Windows mobile and only run on these devices. For this reason, a new version for Android devices has been developed. The details of this second application have just been

explained in this paper. There are more Android devices on the market, so it is easier for the enterprise to reach more clients.

In order to check the value of application, it has been tested with real students. These students, after using the learning objects through their mobiles with the new SCORMmobile application, were evaluated about the knowledges of the educational material stored in these objects. Most of them passed the tests without any problem, in the same way that they had access to the materials in a traditional way, for example using a specific learning platform. In addition, students who have used the application commented their satisfaction about using this new application because it allowed them to make the most of their time.

Conclusions and Future Work

The implemented mobile application allows the visualization on a mobile device of any educational contents packaged in SCORM format. In this way, any learning object packaged in SCORM format will be accessible from a mobile device. Learning platforms allow importing SCORM resources to visualize them. Learning repositories allows importing and exporting SCORM objects. Therefore, the resources in SCORM format stored in learning platforms or learning repositories will be accessible from mobile devices using the SCORMmobile application. That is, access to multiple educational contents can be obtained that already exist in the mobile device. .

Currently, the application has been used in a real environment by several e-learning companies. SCORMmobile allows these organizations to teach making the most of mobile devices.

In its current versions, the application works on mobiles with Windows Mobile and Android operating systems. Further work will be to port the application to other mobile platforms like iOS.

REFERENCES

ADL (Advanced Distributed Learning). SCORM 2004 4th Edition. Overview (2009) Accessed June 18, 2013. http://www.adlnet.gov/Technologies/scorm/SCORMSDo cuments/2004%204th%20Edition/Overview.aspx

ADL (Advanced Distributed Learning). SCORM. Accessed June 18, 2013. http://www.adlnet.gov/Technologies/scorm/ default.aspx

ARIADNE Accesed June 18, 2013. http://www.ariadne-eu.org/

Drire, Pirelli, Laurossy, Derick, Benghezala. "What We Can fit in Mobile Learning Systems?" Proc. IMCL 2006. Amman, Jordan ,2006

eXeLeraning Accessed June 18, 2013. http://exelearning.org/

Fermoso A., Pedrero A., "Smart m-learning reusing educational contents". Highlights in Practical Applications of Agents and Multiagent Systems

Advances in Intelligent and Soft Computing Volume 89, 317-323, 2011

Herrington J., Herrington A., Mantei J., Olney I. and Ferry B. New Technologies, new pedagogies: Mobile Learning in Higher Education. 2009. Accessed June 18, 2013. http://ro. uow.edu.au/newtech/.

Learning Object Metadata Accessed June 18, 2013. http://en.wikipedia.org/wiki/Learning_object_metadata

MERLOT Accessed June 18, 2013. http://www.merlot.org/

Mobile Learning Engine (MLE). Accessed June 18, 2013. http://mle.sourceforge.net..

MoodleTouch (mTouch) of iPhone. Accessed June 18, 2013. http://www.pragmasql.com/home/moodletouch.aspx .

Mobile Moodle (MOMO). Accessed June 18, 2013.. http:// www.mobilemoodle.org/momo18, Last access on 2011 March 14

Nigel H. Lin, Timothy K. Shih, Hui-huang Hsu, Hsuan-Pu Chang, Han-Bin Chang, Wen Chieh Ko,LJ Lin. "Pocket SCORM", icdcsw, vol. 1, pp.274-279, Proc. 24th International Conference on Distributed Computing Systems Workshops - W1: NMSA (ICDCSW'04). (2004)

Reload Leraning Design Editor. Accessed June 18, 2013. http://www.bolton.ac.uk/IEC/EducationalSoftware/REL OAD%20Learning%20Design%20Editor.aspx

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