SCORM Player WP7: a Software Solution for Review and Presentation of the Learning Content on Mobile Devices

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Abstract – The purpose of this paper is to present a software solution we have developed in order to enable download, review and presentation of the learning content on mobile devices. This Windows Phone 7 solution, named SCORM Player WP7, uses SCORM reference model because of its ability to provide the transfer of learning content from one system to another, storing, sharing and reuse of the learning content. Application development is based on the usage of Microsoft .NET C# programming language and modern technologies such as the Silverlight.

Keywords – e-learning, m-learning, software, SCORM.

1. Introduction

E-learning, distance learning, e-education and other related concepts are now widely used both in formal education (primary, secondary, tertiary), and in non-formal education (learning while working, retraining for new jobs, etc.). These terms are used to refer to “a particular form of learning with the use of information and communication technology, especially computers and the Internet, where users access content independently without spatial and/or temporal constraints”[1]. In order to improve the e-learning process, computer network, as well as different types of satellite and mobile networks, interactive TV etc., can be used for user interaction and information delivery. Communication technologies thus enable the use of electronic mail, discussion groups and systems for collaborative learning.

Ongoing progress in the development of communication technology such as Wi-Fi, Bluetooth, wireless LAN and global wireless technologies (GPS, GSM, GPRS, 3G) is providing new capabilities to users. Once combined with mobile devices, these technologies have led towards the creation of mobile learning or m-learning as one of the e-learning sub-areas. This type of learning is present in cases when knowledge is distributed using mobile devices such as smart mobile phones, portable pocket PCs, MP3 players, etc. [1]. M-learning is characterized by spatial independence. Also, this type of learning is adapted to the way of life in urban areas where the number of mobile device users increases on daily bases. Thus, the benefits of m-learning lie in taking advantage of user capabilities including user mobility (user can access data anytime, anywhere), content exchange and collaborating with other users.

The development of new methodologies in learning leads to emerging of new questions and problems which need to be solved. Although learning management systems (LMS) offer various possibilities, the most commonly used functionality of these systems is a static visualization of the learning content. Future development should provide an answer to the question of how to increase the efficiency of learning e.g. how to deploy interactive and intelligent features that will make the learning process more advanced in achieving knowledge? Moreover, there are still major problems in the form of merging and linking learning content from different sources, methods of creating content that can be reused and separated from each other, methods of creating vendor-independent and technology-independent content.

In order to make the learning process, such as m-learning, successful, it is necessary to introduce appropriate standards to ensure the quality of the management, transmission, organization and control of information and knowledge, as an end product of the learning process. In this paper we will present a short analysis of Sharable Content Object Reference Model (SCORM) standard that answers the question of how to create and structure educational content, how to develop software solutions in which these activities occur and how they can be managed in the learning process. The reason for this analysis and the main contribution which will be presented in this paper is the development of mobile phone application which enables users to download, store and visualize SCORM packages.
2. E-Learning Standards

Standards play an integral role in the development of software applications. They ensure interoperability and integration of systems and indicate a certain level of software maturity. This is the case with the development of learning materials and learning management systems also. Until the emergence of standards, learning materials were often tightly coupled to the LMS. Because of this, generated materials could not be reused on other systems so e-learning systems had to be acquired from a single vendor in entirety. In this type of development environment, learning materials were developed separately which resulted in lack of possibility to integrate materials from different sources or move materials from one system to another.

The main goal of the standardization of e-learning process is to develop standardized data model and standardized educational content structure which will enable the usage of the generated materials regardless of the tools used for their creation and the environments in which they are used. It is necessary to ensure that the e-learning content is easy to find, reuse and transfer between different systems. This necessity raises a question - how to ensure the creation of learning content according to the specifications which ensure the reusability of the learning content and its exchangeability between different learning management systems? In this context, the usage of standards in the field of e-learning is essential in preventing the situation where learning content becomes unusable for a number of reasons: a software company has left the market, incompatibilities between tools used to create learning content and LMS used to manage it etc.

There are currently few standards used for the exchange of educational content between platforms which manage the process of learning and appropriate software tools used for content creation. These standards are developed by different international organizations and institutions.

- **Advance Distributed Learning (ADL) Initiative**, [www.adlnet.org](http://www.adlnet.org) – an organization founded in 1997 by the U.S. government with the support of the Ministry of Defense with the aim of providing high-quality educational materials adapted to individual user needs and available anytime, anywhere.
- **IMS Global Learning Consortium (IMS GLC)**, [www.imsglobal.org](http://www.imsglobal.org) – international institution whose members are government members, financial and educational institutions; this institution emphasizes two goals:
  - defining technical standards for the interoperability of applications and services in distributed learning environments, and
  - providing support for the usage of IMS specifications within different products and services worldwide

- **Aviation Industry CBT (Computer Based Training) Committee (AICC)**, [www.aicc.org](http://www.aicc.org) – founded in 1988, this committee represents one of the earliest attempts at introducing e-learning standards. Although primarily focused on the needs of the aviation industry, AICC has led to the development of a particular learning specification named Computer Managed Instruction (CMI), which is widely used.

Often, some of these organizations collaborate with other companies to promote standards for electronic learning technologies. All proposals generated as an output of the efforts of these organizations is submitted to the designated standards body IEEE Learning Technology Standards Committee (IEEE LTSC). Based on the received proposals, the IEEE LTSC tries to develop specifications and industry standards, which are then submitted to ISO for formal internationalization. Eventually, some of these proposals become accredited standards [2].

Prominent researches in the area of e-learning content standardization indicate that the work of various standards organizations has resulted in two prominent e-learning standards [3]: SCORM Content Hierarchy and AICC Content Hierarchy [4]. The SCORM Content Hierarchy consists of content aggregations, shareable content objects (SCO) and assets, whereas the AICC Content Hierarchy consists of courses, instructional blocks and assignable units (AU) [3]. Therefore, SCOs and AUs can be observed as the digital learning objects in these standards [3].

3. SCORM

SCORM can be generically described as a set of technical standards for e-learning software [5]. Since SCORM stands for Sharable Content Object Reference Model, it can be observed as a reference model for shared content objects. Shared content objects indicate that SCORM deals with creating and manipulating shared units of online training materials that can be recycled and used in different systems and contexts. A reference model is something that
indicates what kinds of services are necessary for a problem to be solved e.g. how should these services be combined, which standards are applicable and how should they be used. Reference model essentially reflects the fact that SCORM is not a standard developed from scratch. Members of the ADL organization ADL have noticed that the industry already has many standards that partly solve the problem they were addressing. SCORM is simply a collection of the existing standards which directs developers how to use them properly.

SCORM determines a framework for sharable content objects which meets the following criteria, called the RAID principles [6]:

- **Durability** – content should last and be used long enough to amortize its cost i.e. to be useful as long as it is relevant.
- **Portability** – the transfer of learning content from one environment to another should be possible. The same content should work without modification in various environments until as long as this environment includes a Web browser.
- **Reusability** – the content should be created in the form of small, reusable modules which can be combined in different ways.
- **Accessibility** – users should have the possibility to store and retrieve the learning content to/from repositories. This implies that the information considering the storing and cataloging of data should be directly related to the learning content.

Three basic criteria that describe a reference model followed by SCORM can be distinguished. According to these criteria, SCORM should:

- Provide guidelines that can be understood and implemented by learning content authors.
- Be adopted, understood and used by the wide range of possible economic actors, especially by the learning content authors.
- Enable mapping of any user’s specific model for instructional systems design and development into itself.

SCORM model consists of digital units, assets, sharable content objects (SCO), activities, organization content and aggregations content (Figure 1). This standard specifies exactly how to package the learning objects and SCOs so that they can be stored, copied, moved, archived, uploaded or delivered using SCORM compliant management system. A single packaging can contain one or more SCOs.

IMS Global Learning Consortium has developed a specification used for packaging learning content. This specification is named IMS Content Packaging Specification provides a useful template for generating content organization in the form of a manifesto which should included into the packaging. Manifest is used to list the contents of the package, but also to describe the package using metadata. Manifest can also be used as way to visualize the internal content organization.

Manifest is a XML document which consists of several parts:

- **Metadata** contains descriptive and administrative information considering the package, but also enables querying and locating the package contents.
- **Organizations** describe the way content is organized within a package. They may consist of one or more organizational components, each of which describes a particular structure of the content in the package. Organizations define the sequence of delivery of resources to the end user.
- **Classifications** are attributes which describe the package. They can be used for querying and catalog the package content.
- **Submanifests** describe package content subsets. Submanifests may have their own metadata, organization and resources.

![Figure 1. SCORM content package](image)
4. SCORM Player WP7

SCORM Player WP7 is a Windows Phone 7 application which implements basic operations used for manipulating a SCORM package. Specifically, SCORM Player WP7 implements download, store, display and view functions. Application development was preceded by a survey of existing applications that have similar capabilities. As a result of this research, the application SCORM Player for Google Android and the paper which describes this application [8] have provided a starting point for the development of SCORM Player WP7 application. Also, the basic idea of how should SCORM Player function and appear was given by the SCORM Cloud [9], which is part of a complex LMS system.

The final results of the functional requirements analysis are implemented in the first version of the application:

- Implementation of the SCORM package download mechanism.
- Storing of the downloaded packages in the local phone memory with the ability to delete them.
- Presentation of course (lesson) content with additional user functions:
  - Navigation within the content of a course (with options to view the previous and following lessons and also with option to choose between lessons).
  - Marking previously visited lessons.
- Implementation of undo/redo options
- Creating, storing and deleting records on the application level.

SCORM Player WP7 is a client application which communicates with a server application named SCORM Server. SCORM Server is an application developed for the testing and simulation of SCORM Player WP7. Both applications were developed using Microsoft .NET C# language. Manifest.cs, Storage.cs and MainPage.cs implement the core application logic. These classes take advantage of the events mechanism for the communication. Along with other classes, these classes are shown on the SCORM Player WP7 class diagram (Figure 2).

Manifest.cs class is an auxiliary class which contains the properties of SCORM package manifest file. Thus, the structure of this class coincides with the structure imsmanifest.xml file and its main purpose is to store data temporarily. Various classes, such as Storage.cs, use Manifest.cs class instance to easily and efficiently manage the contents of the manifest file.

Storage.cs class uses Manifest.cs object as helper objects. These helper objects are created during the instantiation of the Storage.cs class instances and their purpose is to reserve memory space needed for storing the SCORM package content, primarily the manifest file. This class implements the following functionalities:

- Retrieving SCORM packages from the server.
- Storing of SCORM packages.
- Acquiring and opening of the local SCORM packages.
- Parsing of the SCORM package structure
- Deleting SCORM packages
MainPage.xaml.cs class manages event processing. It contains the user interface, created via XAML code, "listens" for the user interaction with the application and processes the resulting events. In this way, the application design is separate from the application logic which conforms to the rules of the Silverlight application development. Also, this class determines the controls which will be displayed on the screen depending on the current user activity.

Server application side is a console application named SCORM Server. The server uses Representational State Transfer (REST) style of software architecture for distributed systems. Requests and responses are created with the transfer of resources representations. A resource can be any meaningful coherent concept that can be addressed. Representation of resources is typically a document that captures the current state of the resource [10]. The main classes of SCORM Server application are shown on Figure 3.
5. SCORM Player WP7 application interface

SCORM Player WP7 application interface is based on the usage of Panorama Controls. These controls represent the basic application layout for Windows Phone Panorama Application. SCORM Player application panorama consists of three basic sections which can be accessed by scrolling the screen horizontally (Figure 4). Each section has a menu at the bottom of the screen, which can be increased by pressing the menu surface. Menu elements (buttons and items) will change depending on the currently active panorama section.

SCORM package can be downloaded by selecting the appropriate section and then pressing a “URL path” button. On the screen, a dialog box which is used to enter a SCORM package address appears. After entering the package address, the application establishes communication with the server. If a valid package exists on the server, application displays an unopened packages identified by the package name and address (Figure 5).

Users have the possibility to enter notes. Creation date and note content is stored for each note (Figure 6).

Notes are global objects and do not correspond to a particular SCORM package. Each user can:

- Add a new note.
- Edit an existing note.
- Delete an existing note.

Application section were users will probably spend most of their time while using SCORM Player application is one which displays the contents of downloaded packages. Full package content is displayed within the integrated Web control which, aside from the notes menu options, contains the navigation functions. These functions allow users to efficiently navigate through the package content. Application menu contains "previous" and "back" buttons used to navigate to the previous/next content page, "navigation" button which activates the navigation control and other menu items such as "back", "forward" and "refresh" (Figure 7). Also, SCORM Player WP7 implements undo/redo operations so that the user can always return to the lessons that are not in the order propagated by the package (course) content.
The "navigate" button activates controls which enable navigation through the contents of the currently opened packages. This control visually presents available lessons which are distinguished by the name of the chapter (Figure 7). Here the user can choose any of the lessons by scrolling the content vertically choosing the appropriate lesson. After the appropriate lesson is selected, navigation control is disabled and the integrated Web control which displayed the lesson content is displayed again. Navigation control implements the logic which allows the monitoring of all previously selected lessons and uses this capability to highlight previously selected lessons so users are always aware of the content they have read.

6. Conclusion

Currently a majority of universities defines strategies for the development and usage of e-learning systems. Along with these trends, software community is developing different software solutions and tools which enable the knowledge transfer process using information and communication technologies. In order to preserve the quality of e-learning systems, it was necessary to introduce the standards which ensure the compatibility of different solutions applicable in this field.

Although certain standards already existed, it was important to recognize the importance of integration of the different models and specifications of a uniform standard and a recommended practice. A consensus which was reached among several international organizations for the development of standards in the field of e-learning resulted in the development of SCORM reference model – a standard used for the creation and delivery of learning content between different distance learning management systems. SCORM standard provides transfer of learning content from one system to another, storing, sharing and reuse of the learning content. Due to these characteristics, SCORM has been selected as the standard to be used for the development of Windows Phone 7 applications presented in this paper. This application, called SCORM Player WP7, enables download, review and presentation of the learning content. Application development is based on the usage of Microsoft .NET C# programming language and modern technologies such as the Silverlight.

The first version of the application is experimental and allows users to download courses to their smartphones using wireless network, and afterwards display and preview the downloaded material which was developed according to the SCORM standard.

Through means of contemporary software development technologies, SCORM Player WP7 has been successfully developed as an application which represents the first step towards the development of more advanced and more functional applications. In the near future, this application is expected to be able to interact with a LMS like Moodle, which would enable the active participation of students in the education program via mobile phone as well as the monitoring of student’s work. Further, this application is expected to implement a Run-Time Environment (RTE) model [11] which would allow students to follow the learning materials anywhere, anytime. Thus portability, portability and accessibility, as the basic e-learning and m-learning requirements, will be met which should contribute to e-learning and m-learning become ever more popular.

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References


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