

A SOFTWARE SOLUTION FOR THE DEVELOPMENT OF REUSABLE LEARNING CONTENT

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Abstract. *The purpose of this paper is to present an approach for creating reusable learning content. Our approach is based on the usage of a software solution we have developed in order to enable creation of reusable and portable learning content. This Windows desktop solution, named ScormCreator, provides users with ability to create learning content according to 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.*

Key words: *e-learning, learning content, e-learning tool, SCORM reference model*

1. INTRODUCTION

Nowadays, formal education (primary, secondary, tertiary), as well as non-formal education (learning while working, retraining for new jobs, etc.), widely accepts and uses e-learning, distance learning, e-education and other related concepts. Basic e-learning concepts are well known and represent one of the most significant recent developments in the information systems development [1]. These concepts 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" [2]. E-learning has often been observed as being the same with online learning (OL), Web-based instruction (WBI), Web-based learning (WBL), advanced distributed learning (ADL) and Internet-based training (IBT) [3]. The state of contemporary e-learning processes indicate a growing usage of computer networks, as well as different types of satellite and mobile networks, interactive TV, etc. [4], for the purpose of improving user interaction and information delivery. Communication

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technologies thus enable the use of electronic mail, discussion groups and systems for collaborative learning.

The 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. Recently, a combination of e-learning with mobile devices has led towards the creation of mobile learning or m-learning [5]. As an e-learning sub-area, m-learning represents the next generation of e-learning present in cases when knowledge is distributed using mobile devices such as smart mobile phones, portable pocket PCs, MP3 players, etc. M-learning emphasizes one of the main advantages introduced by e-learning: complete independence of both location and time. E-learning is considered to be flexible, affordable, cost effective and can be done in any geographic location with no travel expenses.

As the development of new methodologies in learning progresses, new questions and problems which need to be solved are emerging. Although learning management systems (LMS) offer various possibilities, the most commonly used functionality of these systems is a static visualization of the learning content. A general expectation is that learning management systems should become more advanced in terms of deploying interactive and intelligent features that will make the learning process more advanced in achieving knowledge. A scope of e-learning development expectations includes resolving problems related to 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.

A certain level of standardization should be included into the learning process to make it successful. In case of e-learning, the introduction of standards ensures the quality of management, transmission, organization and control of information and knowledge, as an end product of the learning process. For this reason, this paper includes a brief analysis of Sharable Content Object Reference Model (SCORM) as one of the most widely adopted technical standards for shared content objects. SCORM 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 a software tool, named ScormCreator, which enables users to easily create a reusable learning content that meets the SCORM standard. A course prepared using ScormCreator represents a reusable content which can be easily accessed and used by students, thus making the learning process more advanced in achieving knowledge.

2. REUSABILITY OF E-LEARNING CONTENT

One of the essential problems faced by the individuals who develop learning content is how to produce reusable high quality learning content. Learning community is in constant demand for mechanisms that enable composing, revising and updating learning content in an efficient way [6][7][8]. The usage of different tools and systems for these purposes introduces interoperability and reusability issues into learning content development process. Standards are one of the means foreseen to be capable of resolving interoperability

and reusability issues in different research and development areas, thus in learning content development field also.

In the process of information system development, standards play an integral role that ensures interoperability and integration of systems and indicate a certain level of software maturity. The development of learning materials is no exception to this claim. Until the emergence of standards, learning materials were often tightly coupled to a particular LMS. This form of tight coupling resulted in learning materials not being reused on other systems. In this type of development environment, learning materials were developed separately which resulted in the lack of possibility to integrate materials from different sources or move materials from one system to another.

The standardization of e-learning process leads towards the development of standardized data model and standardized educational (learning) content structure. Educational content structured according to a standard will make it reusable regardless of the tools used for their creation and the environments in which they are used.

E-learning content should be easy to find, reuse and transfer between different systems. A natural question raised at this point is 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? The answer to this question is found in the use of standards in the field of e-learning.

- *Advance Distributed Learning (ADL) Initiative*, 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.imsproject.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 – 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.

It is not a rare situation that some of these organizations collaborate with other companies to promote standards for electronic learning technologies. Any proposal developed by any organization dealing with e-learning standards is submitted to the designated standards body IEEE Learning Technology Standards Committee (IEEE LTSC). The content of the received proposals is produced into specifications and industry standards by the IEEE LTSC. Afterwards, specifications and industry standards are submitted to ISO for formal internationalization. Eventually, some of these proposals become accredited standards [9].

Prominent researches in the area of e-learning content standardization indicate that the work of various standards organizations has resulted in two widely accepted e-learning standards [10]: SCORM Content Hierarchy and AICC Content Hierarchy [11]. 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) [12]. Therefore, SCOs and AUs can be observed as the digital learning objects in these standards [12].

There are currently few different international organizations and institutions that develop standards used for the exchange of educational content between platforms which manage the process of learning.

2.1. SCORM

SCORM stands for Sharable Content Object Reference Model. It can be generically described as a set of technical standards for e-learning software [12]. SCORM can be observed as a reference model for shared content objects which indicates that SCORM deals with creating and manipulating shared units of online training materials. These units can be recycled and used in different contexts and learning management systems. A reference model is something that indicates what kinds of services are necessary for a problem to be solved, e.g. how these services should be combined, which standards are applicable and how they should be used. Since it can be observed as a reference model, SCORM belongs to a group of standards that were not developed from scratch. The members of the ADL organization have noticed that industry already has many standards that partly solve the problem they were addressing. Thus, SCORM was developed as 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 [13]:

- 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:

- give clear guidelines that can be understood and implemented by learning content authors
- be adopted, understood and used by the wide range of the learning content authors
- enable mapping of any user's specific model for instructional systems design and development into itself

The basic building blocks of SCORM packages are digital units, assets, shareable content objects (SCO), activities, organization content and aggregations content (Figure 1). SCORM gives explicit guidance on 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.

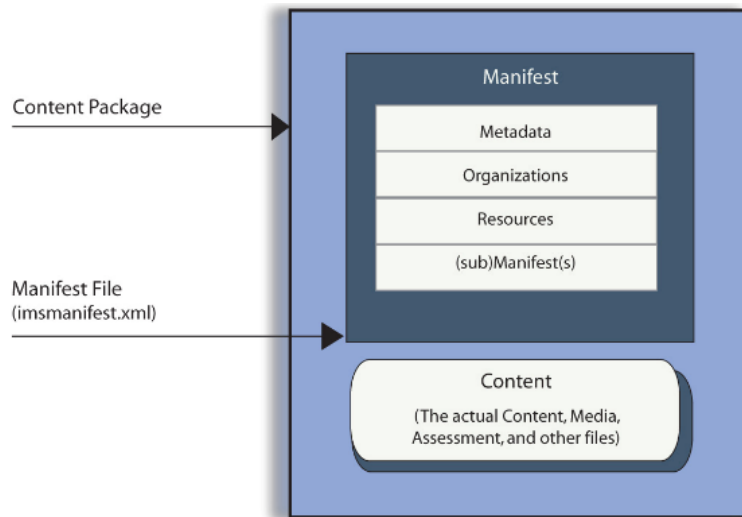


Fig. 1 SCORM content package [13]

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

Manifest is a XML document which consists of several parts:

- Metadata enables querying and locating the package contents; it contains descriptive and administrative information considering the package.
- 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.

3. AN APPROACH FOR THE DEVELOPMENT OF REUSABLE LEARNING CONTENT

An approach we define and describe in this paper is based on the development of a software solution capable of creating reusable learning content. Learning content reusability is insured through usage of prominent learning content development standards. Our solution, named ScormCreator, provides users with the ability to create the learning

content according to the SCORM standard (SCORM reference model) [12]. The motivation for the undertaken development originated from the experiences of lecturers of the Faculty of Electronic Engineering, University of Niš. Within curriculums of the Faculty of Electronic Engineering, University of Niš, there is a certain number of courses that share teaching content but with a different level of details depending on the teaching module. The lectures of these courses currently use Moodle 2.5 LMS [14] and would benefit if the material could be shared and reused among different courses. For this reason, the authors of this paper decided to implement a software solution that develops learning content according to 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. In the following sections, we will give an overview of functionalities, characteristics and benefits our solution brings to users.

ScormCreator is an application which enables development of SCORM 1.2 packages which can be used as a learning content. The basic requirement during the creation of this application was to allow a user to create a SCORM package, which will, next to the asset, contain a SCO which will further create communication with the LMS (in this case, Moodle 2.5 [14] was used as a test). The first step is followed by research on the SCORM standard and all available tools that provide similar functionality. Among all prominent tools, the following tools were analyzed: Trident IDE [15], Microsoft Learning Content Development System (LCDS) [16], eXeLearning [17] and Multimedia Learning Object Authoring Tool [18].

Free solutions that are found are mainly Web applications developed by JavaScript (for communication with the LMS), while the tools which use Microsoft .NET and Java technologies are primarily developed within individual organizations. The *ScormCreator* application is developed in Microsoft Visual Studio 2012 as a C# Windows Forms application. .NET Framework 4.5 was used for its development.

The user of this application has the ability to create a new SCORM package, or to open the existing one, add a SCO and then also add the appropriate HTML page or tests in the SCO. As it is possible to pack the SCORM package into a zip archive, it is also possible to change the order of resources. Additionally, the user is not limited to a single SCO inside SCORM, or to one SCORM package with which he/she will work in the application. The user can open multiple packages on which he/she can operate simultaneously. Furthermore, *ScormCreator* easily creates HTML content with all resources that one HTML page can support: text, images, flash, records from an online repository of video material (specifically from YouTube), tables with different styles applied, etc. *ScormCreator* also creates tests with the following types of questions:

- Questions in which a student can choose the correct answer in a group of answers.
- A true-false type of questions.
- Questions in which a student's answer is of numeric type.

The SCORM 1.2 package, created using *ScormCreator*, consists of the root folder which includes the following files:

- An XML manifest file and all definition files (.XSD) which are referenced in this manifest file. The XML manifest file is named *imsmanifest.xml*, while definition files are named: *adlcp_rootv1p2.xsd*, *ims_xml.xsd*, *imscp_rootv1p1p2.xsd*, *imsmd_rootv1p2p1.xsd*.
- A folder *shared* that contains files necessary for communication with the LMS.

The `imsmanifest.xml` file describes the content of the package and each SCORM package must have this file in its root folder. XSD (XML Schema Definition) files specify how to formally describe the elements in an XML document. In the SCORM package, they are used to validate the XML manifest file. They also describe the manifest format and must be placed in the root folder of the package.

In order to create a SCORM package, the files shown in Figure 2 are essential. The necessary XSD files do not have to be improved, while the manifest file needs to accurately describe the structure of the SCORM package and it has to be updated by the program each time the content of the SCORM package changes. The content and structure of these files depend on the version of SCORM packages.

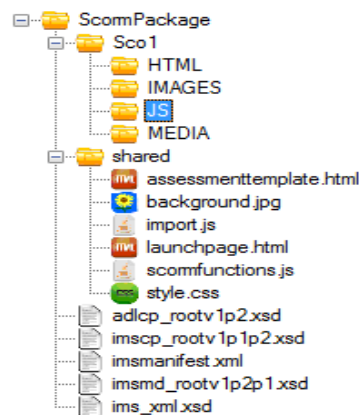


Fig. 2 Content of created SCORM package after adding SCO-a

The folder `shared` contains files that enable communication between SCORM packages and the LMS. Those files are:

- the `scormfunctions.js` file that contains API's functions for communicating with the LMS,
- `launchpage.html` file which represents the first page that will appear once the SCORM package is launched (also provides functions for navigating through the content of the package),
- `assessmenttemplate.html` file which contains functions for creating questions and checking the correct answers in the created test,
- files `background.jpg` and `style.css` (responsible for the layout of the home page `launchpage.html`) and,
- `import.js` file that allows to change the display order of HTML pages and tests.

As shown in Figure 2, the added SCO1 folder contains additional folders: HTML, IMAGES, JS and MEDIA. These folders allow better organization of resources that are located in the SCO. In the HTML subfolder, a HTML page is added and in the IMAGES subfolder, images of the SCORM package are added. The JS subfolder contains questions that make the test in the SCO, and in the subfolder MEDIA flash animations are located.

4. OVERVIEW OF FUNCTIONALITIES

As a result of the analysis of prominent learning content development tools, the first version of ScormCreator tool implements the following functionalities:

- SCORM package manipulation (creating, opening, removing and archiving SCORM packages)
- Creating learning content in the form of HTML pages
- Development of different types of tests (tested on Moodle 2.5 LMS)

4.1. Creating and opening SCORM package

A user creates the new SCORM package by clicking on the CreateSCORM button and creating or selecting the folder that represents the root folder of the SCORM package. Other folders and files are created automatically. After creating the package, the user can immediately see the structure of SCORM packages in the program. The process of opening the SCORM package is similar.

4.2. Removing SCORM package

Removal of the SCORM package is done by selecting a specific package and clicking on the *RemoveSCORM* button, after which the selected package is removed from the list of the open SCORM package in the program.

4.3. Packaging SCORM package in zip archive

By selecting the open package and clicking on the ZipScorm button the user gets the zipped SCORM package in a location where there is also a package with the same name.

4.4. Creating SCO inside SCORM package

Adding of a SCO in the package is performed by choosing the SCORM package, to which a new SCO is added, and creating a folder inside of this package. Automatically created subfolders inside the folder are initially empty. The structure of the SCO is shown in Figure 3.



Fig. 3 Structure of SCO

When the new SCO is added, the *imsmanifest.xml* file (shown in Figure 4) is updated (the new SCO is added to this file), because the *imsmanifest.xml* file must correctly describe the structure of SCORM packages at any time.

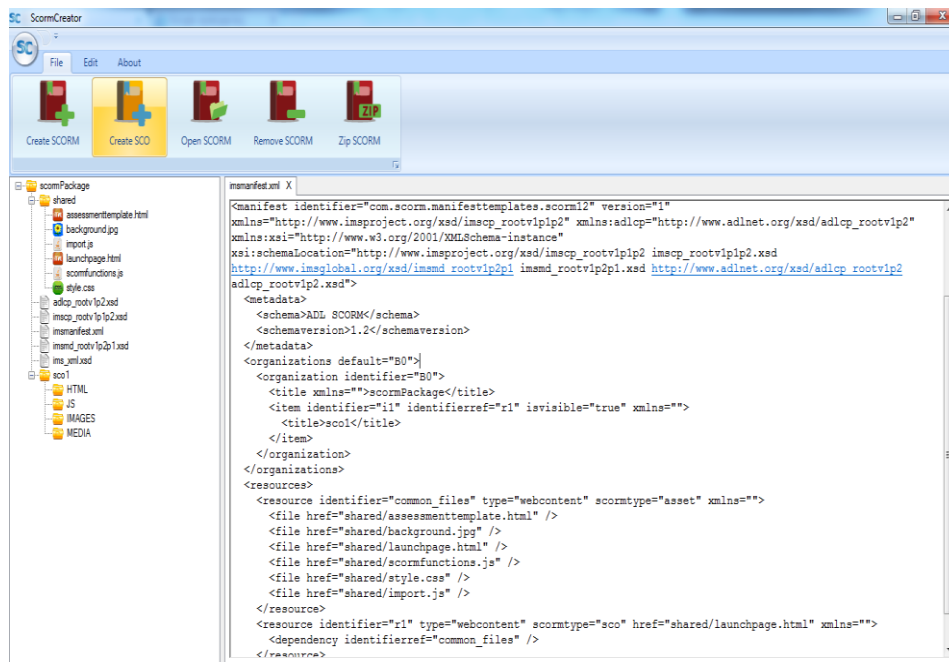


Fig. 4 *imsmanifest.xml* file after adding new SCO

4.5. Creating and updating HTML page

After creating the SCORM package and SCO, it is possible to create a HTML page by selecting the HTML folder inside the SCO and clicking on the *AddHtml* button (or choosing the equivalent option in its submenu). Afterwards, the HTML editor, which allows easy creation of a HTML page, is displayed to the user. The CKEditor [19] is used for creating HTML pages (Figure 5). This is a free and open source Web text editor, which allows modification and adaptation to the desktop application.

ScormCreator allows for a change in the layout of the HTML page (it can be shown as an HTML code or display of a HTML page, as in the browser). Besides creating and saving HTML pages, updating HTML pages is also possible.

The following occurs after saving the HTML:

- Depending on the type of resource, the program searches for all resources in the HTML page and copies them to the right location in the SCORM package.
- The list which contains the SCORM package is updated and displayed on all newly created files.
- All resources are added to the appropriate location in the *imsmanifest.xml* file.

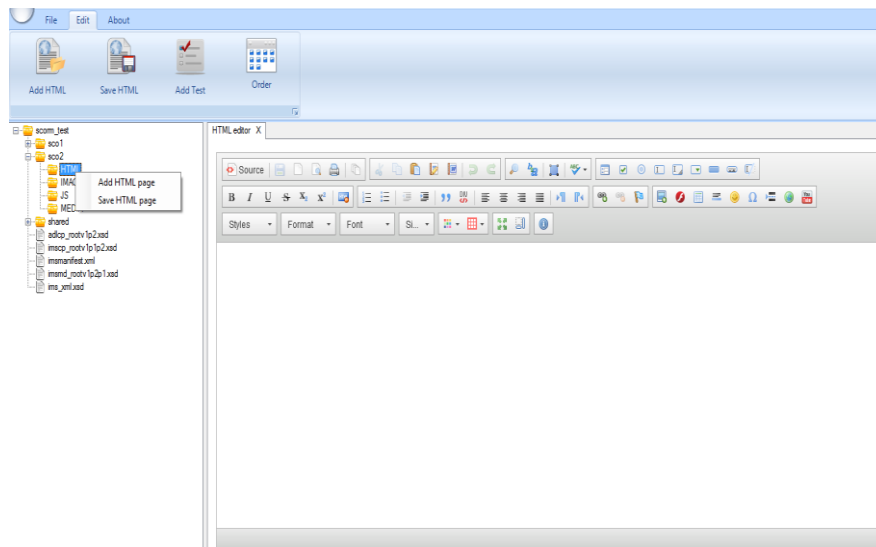


Fig. 5 Form for creating a HTML page

4.6. Creating tests

By selecting the SCO and clicking on the AddTest button, the user adds questions. The user can insert tree types of questions:

- Choose the correct answer among several given answers.
- Choose the true or false answer.
- A student provides an answer in the form that has a numerical value.

After clicking on the Save button, the user saves the question entered.

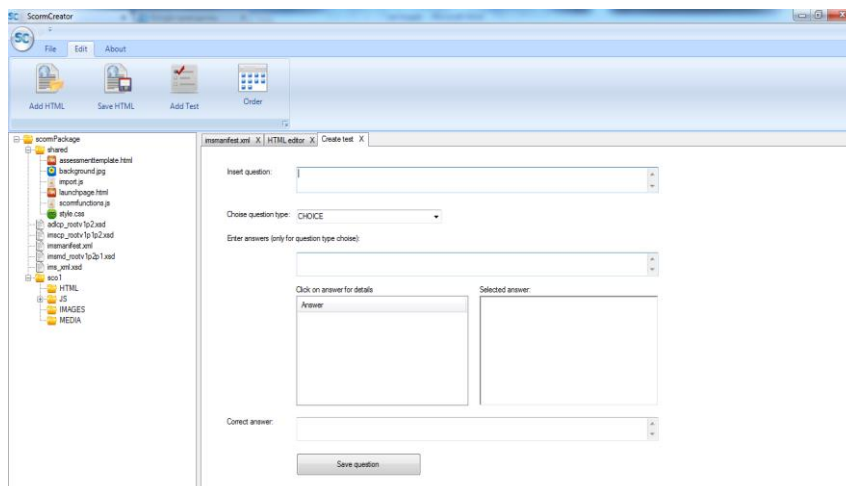
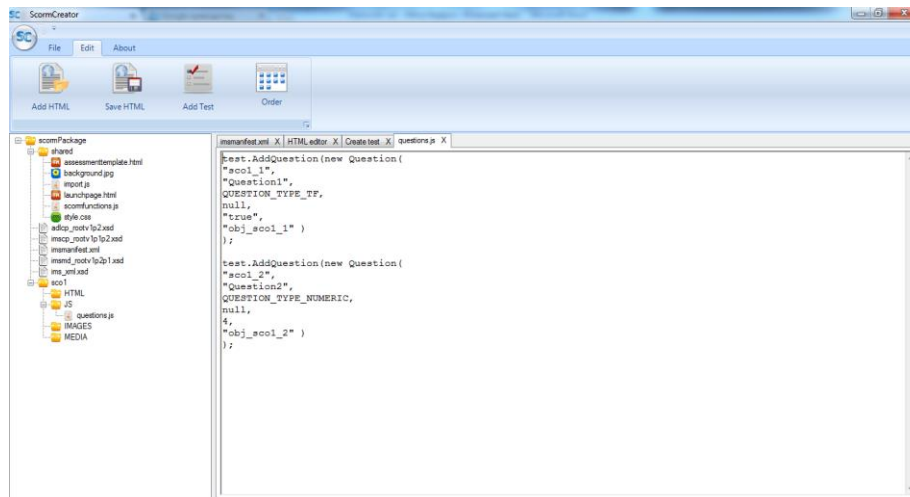


Fig. 6 Form used for creating questions

By saving a question, a particular format of the question is created and saved in the questions.js file, which is located in the subfolder JS within the selected SCO. This file, which belongs to the selected SCO, will contain all test questions. The structure of questions is very simple and always the same. First, the id question is set, followed by the text of the question, answers to the question, the correct answer and the object id. The content of the questions.js file is shown in Figure 7.



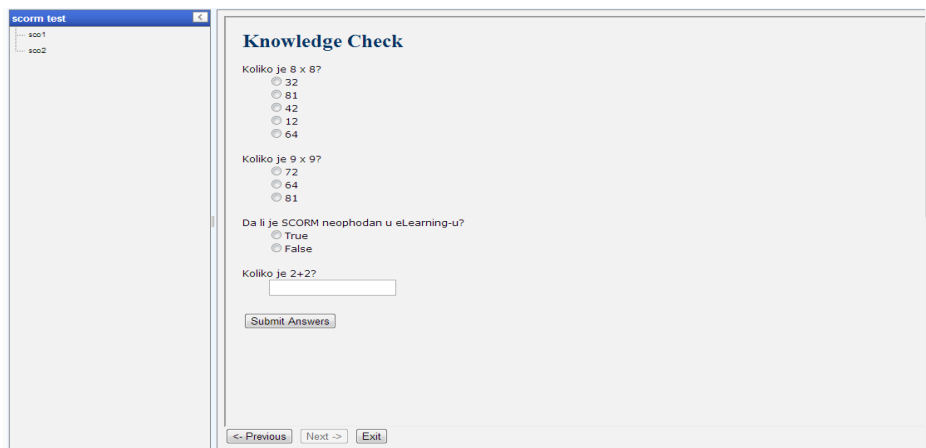
```

test.AddQuestion(new Question(
  "scol_1",
  "Question1",
  QUESTION_TYPE_TF,
  null,
  "true",
  "obj_scol_1"
));
test.AddQuestion(new Question(
  "scol_2",
  "Question2",
  QUESTION_TYPE_NUMERIC,
  null,
  4,
  "obj_scol_2"
));

```

Fig. 7 Content of questions.js file

The questions are arranged in the order of addition, and this sequence will be used when the questions are displayed. The display of the created course on Moodle (type of LMS that is used for testing) is shown in Figure 8.



scorm test

Knowledge Check

Koliko je 8 x 8?

32

61

42

12

64

Koliko je 9 x 9?

72

64

81

Da li je SCORM neophodan u eLearning-u?

True

False

Koliko je 2+2?

Submit Answers

<< Previous Next >> Exit

Fig. 8 Layout of the created course on Moodle

After submitting the answer, the user receives information about the total result, as well as information on which question is answered correctly and which is not, as shown in Figure 9.

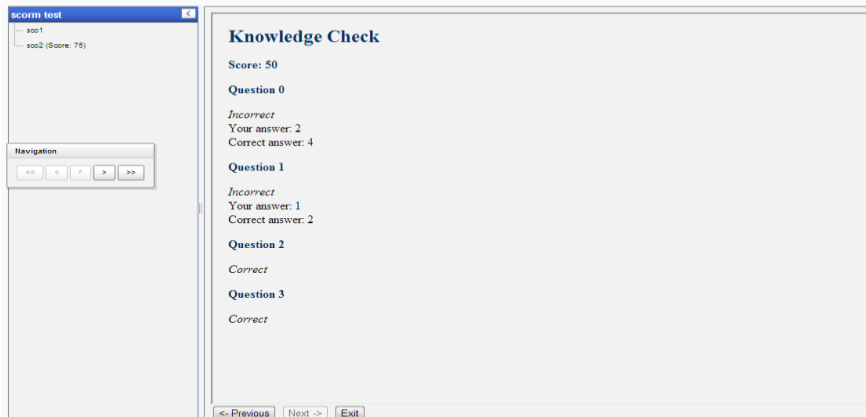


Fig. 9 Display of results after submitting answers

4.7. Reordering the preview of HTML pages and tests

When adding HTML pages and tests, the order of addition is stored. If the user does not make additional changes, this order will become the default order. By selecting the desired SCORM package and clicking on the Order button, the user opens a new form that displays all the resources (HTML pages and tests within the SCORM package, including all SCO's within the package), their order, name and location. The Carousel control is used for displaying (Figure 10).

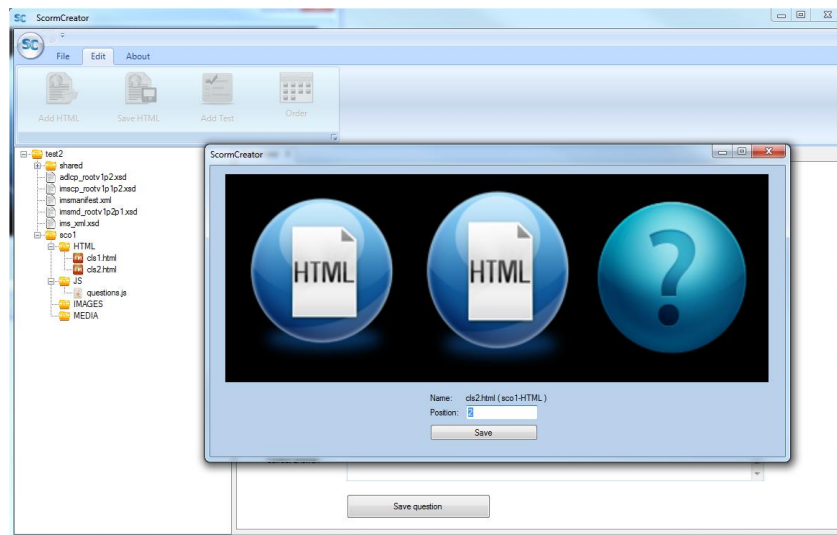


Fig. 10 Reordering resources

It allows visibility and dynamics in viewing the current sequence of resources. Depending on where the selected element is, clicking on the particular resource that is not in the middle of the form causes a shift in resources to the left or to the right side, and then the selected element becomes central. By clicking on the resource, the user receives information about its name, location and relative position to other resources. If the user is not sure of the element in question, by double-clicking on this resource, he/she will minimize the form and the previous form (in the HTML editor) will display the desired resource (as the HTML page or test depends on the type of the chosen resource).

5. CONCLUSION

As the majority of universities defines strategies for the development and usage of e-learning systems, a significant attention is given to improving e-learning acceptance [20]. Software development community follows these trends and contributes through a development of solutions and tools which enable the knowledge transfer process using information and communication technologies. For the purpose of improving the compatibility and interoperability of the developed software solutions, different learning content standards were introduced.

Although certain standards were already proposed, it was important to recognize the importance of integration of the different models and specifications of a uniform standard and a recommended practice. SCORM reference model is a result of a consensus which was reached among several international organizations for the development of standards in the field of e-learning. It represents 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 application presented in this paper. The application presented in this paper, named ScormCreator, enables the creation of SCORM packages which, next to the asset, contain a SCO which will further create communication with the Moodle 2.5 LMS. The ScormCreator application is developed in Microsoft Visual Studio 2012 as a C# Windows Forms Application using NET Framework 4.5.

The first version of the application is experimental and allows users to create and open SCORM packages, remove SCORM packages, package SCORM packages in a zip archive, create SCO inside a SCORM package, create and update HTML pages, create tests and reorder HTML pages and tests within a SCORM package. This application is expected to be improved in the near future with additional functionalities such as automatic export of created SCORM packages onto Moodle LMS. Also, authors of this paper plan to develop mobile and Web versions of ScormCreator which will improve application portability with aim to make to e-learning and m-learning become ever more popular and easier to achieve.

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