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WHITE PAPER

SCORM 2.0: Assessment Framework

Business Area Data Representation and Interfaces

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1. Introduction

Standards play a vital role in the advancement of innovation and technology. Commonly, the development of standards points toward a certain process or technology that becomes a technology trend and has reached a degree of marketability that requires a need for particular consensus-based agreements. Learning technology standards are usually developed to be used in the processes of learning system design and implementation. They aim to ensure mainly interoperability, portability and reusability. These attributes shall apply to both the learning systems and the content. An additional requirement concerns the metadata that describe the content and are managed by the learning systems.

Standards make learning technology interoperate in a global network. The ADL Sharable Content Object Reference Model (SCORM) has become the industry standard for web based learning.

This White Paper concerns the consideration of testing and assessment issues in SCORM 2.0 in an improved manner, in order to enhance the learning and knowledge acquisition capabilities of SCORM-compliant learning content. Testing and assessment will remain an inseparable part of learning, and particularly for instructional systems design for traditional as well as web based education and training. The purpose of testing is to determine if learning objectives have been accomplished. Assessment data are observations or facts that must be collected, organized, and analyzed to become useful. Thus, assessment has many roles. On the one site, it is critical for measuring the student's achievement within the learning process, i.e. students can understand to what extend learning objectives have been accomplished. On the other site, it can also be used as a teaching tool to help students better understand concepts and enhance their skills. In addition, the instructor can realize what students are understanding as well as the concepts that need further clarification.

A standardization of web based LMS/LCMS will significantly influence testing and assessment practices, and may result in either benefits or deficits for testing and assessment solutions depending on the way that will be find out to adopt the emerging standards.

2. Problem definition

Web based learning management systems (LMS), and especially learning content management systems (LCMS) should involve a very wide range of integrated testing and assessment features. Reliance on multiple choice tests limits the kinds of skills that can be measured. Web based testing offers the opportunity to develop new types of questions and create new learning situations, especially those that can assess complex problem-solving knowledge and skills.

By now, SCORM has not directly addressed testing and assessment issues, nor if a SCO can be regarded as an assessment even if creating a test as a single SCO is perhaps the easiest way of adding a test in a SCORM-compliant system. The subsequent design and use of proprietary assessment developments was the result of these initiated concerns in the content development communities. Moreover, this fact led to a loss of interoperable and reusable solutions.

Currently, assessment can be implemented in SCORM with the help of learning controls internal to the SCO. One of the data model elements specified in the Runtime Environment (RTE) data model is *objectives*, and it refers to learning goals and corresponding progress data. This data model element *objectives* is context free and able to be linked and interpreted within the learning goals of the particular SCO. By now, it is not possible to pass test items outside of the SCO itself. Consequently, pedagogically valuable test items cannot be combined in a new manner to generate unique learning tests, and assessment situations.

In addition, SCORM does not address the reuse of single test items. Due to the fact that the test items internal to the SCO have a context free HTML structure, exchange between these items and the LMS/LCMS is not feasible. Moreover, behavior and control cannot be handled in a standardized interface.

The content packages contain a combination of data that represent the particular XML structure, functions and the content itself. The problem is how to interpret the data when frequently a metadata description is not available, and single data cannot be determined without the particular context. Consequently, the LMS/LCMS is not able to directly find test items in the content packages, and to use these items for an internal assessment. Thus, pedagogically valuable test items cannot be reused.

Further, current opportunities to categorize and store test items in the LMS/LCMS by using metadata are not sufficient to completely understand and reuse the test items. Due to the lack of appropriate descriptions of learning goals, feedback, and evaluation features, the tutors are not able to combine test items into a test arrangement according to the individual profiles of the learners.

3. Use cases

Based on our experience with design and implementation of assessment in LCMSs, the following use cases can be created to point out situations, which address current assessment demands and standardization needs.

Starting point is enterprise education and training based on a SCORM compliant e-learning platform.

- Management decision: „*reusing test items in an extern e-assessment environment*”

The enterprise management decided to extend the available e-learning environment with components towards competency management. Employees who are going to improve their qualification use the new environment that supports also certification. In order to properly determine the individual competency profile of an employee, the user should take an exam based on test items, which refer to the learning courses booked in the e-learning environment. Thus, there is an enterprise need to reuse the test items included in the SCOs and to present them according to the assessment situation in different templates/layouts in the new e-assessment environment.

- Authors' demands: „*providing content for SCOs and an extern e-assessment environment*”

The enterprise management requires editing existing, and creating pedagogically valuable new SCORM-compliant content. The requirement concerns also a seamless integration of that content into an extern e-assessment environment that supports certification. Furthermore, the test items must contain information about the particular learning goals, levels of difficulty, and levels of comprehension. Authors have to separate the content from the layout, in order that the test items can serve various environments.

- Tutors'/educators' demands: „*arranging tests for an exam*”

The task of a tutor/educator is to supervise the learners in specific matters, and also to arrange exams based on the individual profile of each learner or learning group. The tutor/educator has an executive access to the content provided in the e-learning environment as well as to the exams stored in the new e-assessment environment. The tutor/educator is allowed to select proper test items from the SCOs stored in the e-learning environment, and export them into the e-assessment environment to design new tests. This process has to ensure the proper correspondence of the test items to the learning goals, levels of difficulty, and levels of comprehension. An important issue is to make sure that the tutor/educator may select the test items if his/her competency is graded higher than the learning goal to be achieved with this particular test item (quality management requirement). Furthermore, the tutor/educator has access to assessment and statistical data of the learner's achievements to be able to monitor appropriate certification procedures, or to suggest additional exams.

4. Assessment requirements

Web-based assessment plays a fundamental role in evaluating the learner's knowledge acquisition and achievements. Web-based assessment primarily needs:

- High level of interaction in order to map various question types like open, semi-open and closed question types (multiple choice, ordering tasks, fill-in-the-blank tasks, open questions, drag and drop, etc.) onto the user interface
- Secure and controlled access to the content
- Reusability and interoperability of the content
- Tracking the learner, monitoring and processing his/her answers
- Assessing the results and generating statistical data

Exchange and sharing of test items between assessment systems or databases is vital for content developers and e-learning providers. Thus,

- A uniform exchange format based on XML is crucial for ease of implementation and for interoperability with both SGML and HTML, and consequently for sharing structured data across LMS/LCMS, and for mapping the above mentioned various question types.
- It is desirable to include MathML statements to create formulas, and to involve diverse media elements such as Flash animations, movies, simulations, VR worlds, images, etc.
- An additional aspect concerns provision of feedback and hints to encourage and motivate the user.
- Adaptivity to the individual knowledge of the user requires the availability of numerous test items attached to a particular subject, and which correspond to various levels of knowledge.
- Metadata description of both, the test items, and the tests will enable reusability, and interoperability between authoring, assessment, delivery systems or item banks. This requirement will allow the external systems to include and interpret the test items in the particular assessment situation.

5. Proposed solution, integration and technical issues

A standardized assessment format can be integrated in the following way by considering two integration points of view:

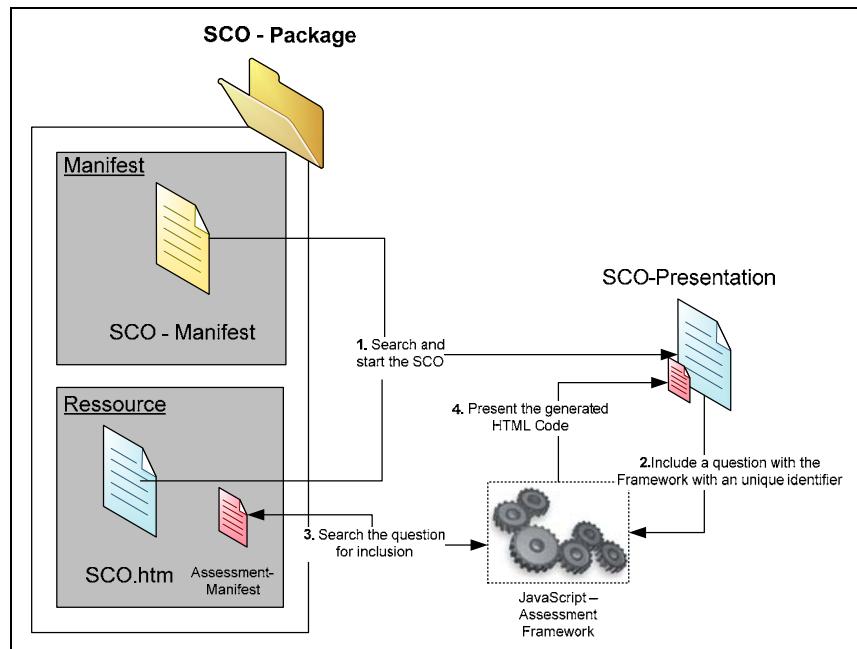
- LMS/LCMS

The manifest file of the SCORM-compliant content package has to incorporate a link to the particular standardized assessment file. The mandatory `<resource>` element contains a *list of files* and other resources. It enables the extraction of all the data required for the particular test item.

- Content developer

The content developer must have the opportunity to transform the test items into the standardized assessment file, and to display these test items in the learning object. Please notice that it is not important whether the test items arrive from a static HTML file, or from the standardized assessment file.

The assessment integration in SCORM requires the design of a framework that parses the adequate standardized assessment file and pre-processes the test item for the particular learning object as shown in **figure 1**. It is suitable to design this framework in JavaScript - one the one side, due to the widely use of JavaScript for client-side web development, and on the other side, due to the familiarity of the SCORM-community with the use of frameworks such as the API Wrapper for SCORM2004. Once the framework is created it can reliably be applied to every SCORM-compliant system.

**Figure 1: JavaScript Assessment Framework**

The content package contains all files required to deliver the content package via a SCORM RTE and/or LMS/LCMS. The framework has to find the standardized assessment files, in order to extract the particular test items. This can evolve to a complicated task. Thus, it is recommended to extend the `<resource>` XML files by specific file characterizations. Particularly the `<file>` tag has to be extended by a type "attribute". This attribute refers to the semantic of the data such as content, layout or standardized assessment. The type "content" indicates content files that reflect learning goals. In contrast, layout files reflect the visual appearance of the content package. In addition, it is possible to state the MIME-type of the particular media formats. The following **listing 1** illustrates the composition of such a `<resource>` file.

```

<resource identifier="RA1-2" type="webcontent" scormType="sco" href="sco1.html">
    <file identifier="RA1-2" href="sco1.htm" type="layout" mime-
        type="application/xhtml+xml"/>
    <file identifier="RA1-2" href="background.jpg" type="layout" mime-
        type="image/jpeg"/>
    <file identifier="RA1-2" href="formula.jpg" type="content" mime-
        type="image/jpeg"/>
    <file identifier="RA1-2" href="video.mov" type="content" mime-
        type="video/quicktime"/>
    <file identifier="RA1-2" href="question1.xml" type="standardized assessment"
        mime-type="text/xml"/>
</resource>

```

Listing 1: Extension of the `<file>` tags

6. Implementation

Some aspects of the proposed framework for assessment integration in SCORM are being implemented by the Business Area Data Representation and Interfaces, Fraunhofer IDMT, in a project named EDMedia. EDMedia is a LCMS that ensures the interoperability of the content by the use of XML based exchange formats. The implementation of the ADL SCORM 2004 3rd Edition standard enables exchange and reusability as well as processing of SCORM compliant learning objects (SCO's).

7. Summary and recommendations

Currently, assessment can be implemented in SCORM with the help of learning controls internal to the SCO so that assessment interaction can only be understood and be used by the SCO itself. To extend SCORM in terms of web-based assessment, and especially reuse and interoperability of test items and tests, these items have to be determined, extracted and available in a standardized format. This format will guarantee that every LMS/LCMS can understand the data packaged. Then, the standardized assessment format can be integrated in SCORM by applying the JavaScript Assessment Framework proposed in this White paper, in order to enhance the learning and knowledge acquisition capabilities of SCORM-compliant learning content.

In addition, the major testing and assessment issues, which have to be tackled by SCORM 2.0 concern:

- Addressing the test items by the parent LMS/LCMS (de-encapsulation of the SCO)
- Addressing the test items from several SCOs to be combined in a new manner, in order to design unique learning tests, and assessment situations
- Separating the HTML structure of the test items from the layout
- Adding metadata to the test items to improve search, retrieval and reuse of the test items