

The Rising Challenge for Assessment Standardization in Web Based Learning, Education and Training

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Abstract: By now, standardization in Web Based Learning, Education and Training has only vaguely or indirectly addressed testing, and performance and quality assessment issues. Standardization of web based learning management systems will significantly influence assessment practices: It may result in either benefits or deficits for assessment solutions depending on the way that will be found out to adopt the emerging standards. This paper concerns the consideration of performance and quality assessment issues in SCORM 2004 in an improved manner, in order to enhance the learning and knowledge acquisition capabilities of SCORM-compliant learning content, on the one hand, and to ensure the evaluation of the impact of educational services, on the other hand.

Keywords: E-learning, performance and quality assessment, standardization, SCORM

Introduction

Economic competition and employability are in fact the key words all over the world. The main challenges of the knowledge and learning society, the responses of industry to cope with them and the consequences for learning technologies, indicate company-specific qualification requirements and more options for the individuals. Thus, learning performance standards move into the focus of recent developments.

Recently, the concentration and strengths of those who are developing standards for educational business and industry training needs is expanding: Various R&D projects deal with standards and their adoption. The reason for this development concerns the rather short history of e-learning that reflects now a clear movement from the earliest approach focused on contents towards the current interest on creating learning arrangements. In these learning arrangements, the learners perform different learning activities depending on their personal characteristics and initial knowledge. Therefore, the assessment of learning effectiveness becomes a driving force.

In addition, lack of standards-based interoperability is cost-effective as content cannot be exchanged. Standards and standardization processes are important to adopters and ultimately to end users. 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 and training.

This paper concerns the consideration of performance and quality assessment issues in SCORM 2004 in an improved manner, in order to enhance the learning and knowledge acquisition capabilities of SCORM-compliant learning content, on the one hand, and to ensure the evaluation of the impact of educational services, on the other hand. In order to illustrate the demands for performance and quality assessment technology standards, it may be useful to stress on few problems and requirements that are reflected in the next section.

1. Identified Problems

1.1 Reflection on Testing, and Performance and Quality Management

In the past, the term assessment was used to refer particularly to the process of determining the extent to which learners have mastered a subject. It has recently been extended in the academic context to cover all uses of evaluation. Testing and performance will remain an inseparable part of learning, and particularly for instructional systems design for traditional as well as web based education and training. In addition, the need for quality management rapidly grows up as the heterogeneity of training institutions and associations results in a variety of interests, goals, and contents of teaching and learning. Economic competition and employability increasingly raise the demand for implementation, maintenance and audit of quality criteria for educational services and vocational 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 hand, it is critical for measuring the student's achievement within the learning process, i.e. students can understand to what extent learning objectives have been accomplished. On the other hand, 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 explanation.

Quality management concerns the organizational part of educational services, and its purpose is to ensure the evaluation of their impact. Over the past years the selection criteria for educational services and vocational training programs toward receiving governmental support have been strengthened. There is a rising social requirement to implement quality management approaches in instructional systems for traditional as well as web-based education and training.

1.2 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 performance 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 2004 has not directly addressed testing and performance assessment issues, nor if a SCORM-compliant learning object (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 2004 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 2004 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.

Concerning quality assessment, educational services, and the teaching/learning evaluation and assessment need a clear distinction from monitoring organizational processes. Training institutions have to determine and manage numerous processes to work effectively. Evidently, it is important to identify also the assessment demands of the pedagogical dimension that represents the basis for teaching and learning activities toward effective web-based education and training. A holistic assessment environment is needed within which the programs or projects are operating, and which offers e-learning educators a better theory, principles, and pedagogy to build up their future teaching approaches, in order to advance student learning, and to more effectively serve the organization.

The next section is concerned with identifying key design requirements toward a model for the integration of performance and quality assessment matters in web based education and training environments.

2. Assessment Requirements

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

- 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. There are industrial and proprietary formats available, for example the IMS Question and Test Interoperability (QTI) Specification.
- 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.
- it is important to provide 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 to 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.

In addition, the major testing and assessment issues, which have to be resolved for a SCORM integration 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.

Quality assessment requires a quality management system, which supports the implementation and maintenance of quality criteria for educational services. Commonly, the institutional and administrative processes can transparently be documented on the basis of ISO 9001. In the field of teaching and learning modalities, the German Training Association (DVWO, Dachverband der Weiterbildungsorganisationen e.V.) extended the established ISO 9001 basis of the process-based model (ISO 9001) by specifying quality policy and quality objectives, and adding the DVWO Process Model [1]. Using DVWO norms sets a focus on the learner's demands and puts the pedagogical dimension in the centre of the assessment of e-learning measures. The main advantage of this model is the opportunity for evaluation of e-learning systems and for monitoring didactic effectiveness of e-learning measures. In addition to the eight ISO 9001 quality management principles the DVWO Quality Model has four further requirements:

- The educational services must be structured on the basis of the DVWO Quality Model.
- Quality criteria must be named using the Competencies Pyramid (see below) in conjunction with the Content Objective Matrix (see Table 1).
- Curricula can be arranged in an open or closed manner. A curriculum is the set of courses and their contents. It describes the collective teaching, learning and assessment materials that are available for that particular educational services or the (vocational) training program. A closed curriculum has specific goals and is partially or entirely determined by the training institution. It is often used in the education of technical knowledge. When students should be able to pursue their own educational interests, an open curriculum is preferable. By planning an open curriculum casual objectives as general goals are appointed. Then, the student and the teacher intensify these general goals in behavioral terms according to Mager [2].
- Educational services must be assessed and evaluated.

The Content Objective Matrix and the Competencies Pyramid point out learning objectives and the required measurement of training outcomes, which are necessary for assessment and evaluation.

Each level of the Competencies Pyramid defines a state of training experience. Like Bloom's taxonomies, it is a hierarchical construct to subsume that participants have to master each level before progressing to the next level. The Competencies Pyramid represents a tool to construct objectives for learning programs, training courses and further educational services. It can facilitate the transfer, transparency and recognition of learning outcomes assessed by self-evaluation or certified by expert centers as well as ISO 9001 certification institutions. It can also encompass detailed descriptions of particular qualifications, learning pathways or access conditions [3].

As illustrated in **Table 1**, in the Content Objective Matrix of the DVWO Quality Model the following components appear:

Table 1 Content Objective Matrix

Content (what)	Teaching (who)	Learning (how)	Transfer (wherefore)
Learning content shaped by customers' expectations	Teachers' qualifications identified with the Competencies Pyramid	Learning objectives identified with the Competencies Pyramid	Recognition of learning outcomes identified with the Competencies Pyramid
Competency level	6	5	4

Not surprisingly, the technical and standardization directions according to these assessment requirements have to be remedied by additional solutions. Reflecting on the implementation of performance and quality assessment strategies for web-based learning and training, the next section discusses essential aspects of suitable implementation strategies, which are correlated with achieving the learner's appropriate knowledge acquisition, on the one hand, and the organizational advancement, on the other hand.

3. Proposed Solution for a SCORM-Compliant Implementation

The assessment implementation 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 hand, due to the widely use of JavaScript for client-side web development, and on the other hand, due to the familiarity of the SCORM community with the use of frameworks such as the API Wrapper for SCORM 2004. Once the framework is created it can reliably be applied to every SCORM-compliant system.

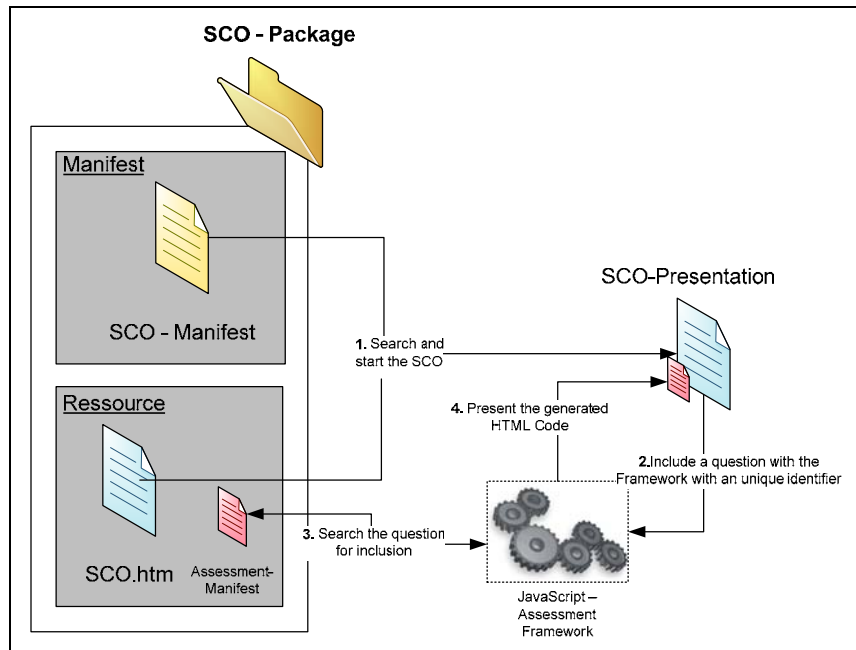


Figure 1: JavaScript Assessment Framework

The content package contains all the 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

The DVWO Quality Model sets up the requirement to assess and evaluate the implementation, and the maintenance of the open and closed curriculum. The taxonomies of the Competencies Pyramid can be reflected in the SCORM Content Aggregation Model

(CAM) due to the definition of the learning packages' structure in that model. Here an embedding in the mandatory *<resource>* element that contains a *list of files* and other resources is possible due to the opportunity to represent the taxonomies as a XML structure. Every item will reflect one taxonomy and one competency level and refer to the *<resource>* element as illustrated in **Figure 2**.

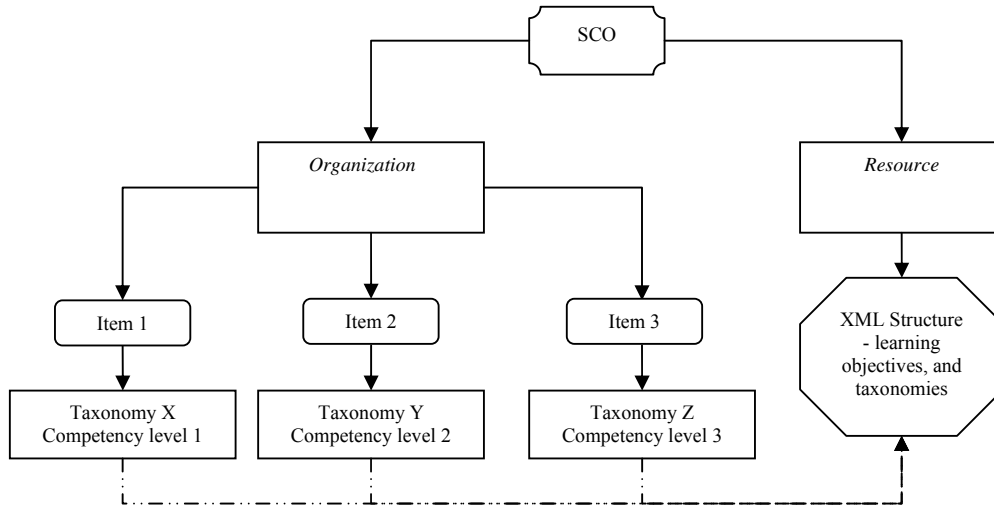


Figure 2 Mapping of the Competencies Pyramid onto the SCORM CAM

The SCORM Sequencing and Navigation (SN) part concerns the control of the learning process. Consequently, it can reflect the content – learning objective – scheme, and particularly the open and closed curriculum matters. As the structures are already accessible, only the availability of these learning objective structures in the particular Learning Management System has to be ensured. **Figure 3** illustrates the different approaches for the open and closed curriculum evaluation.

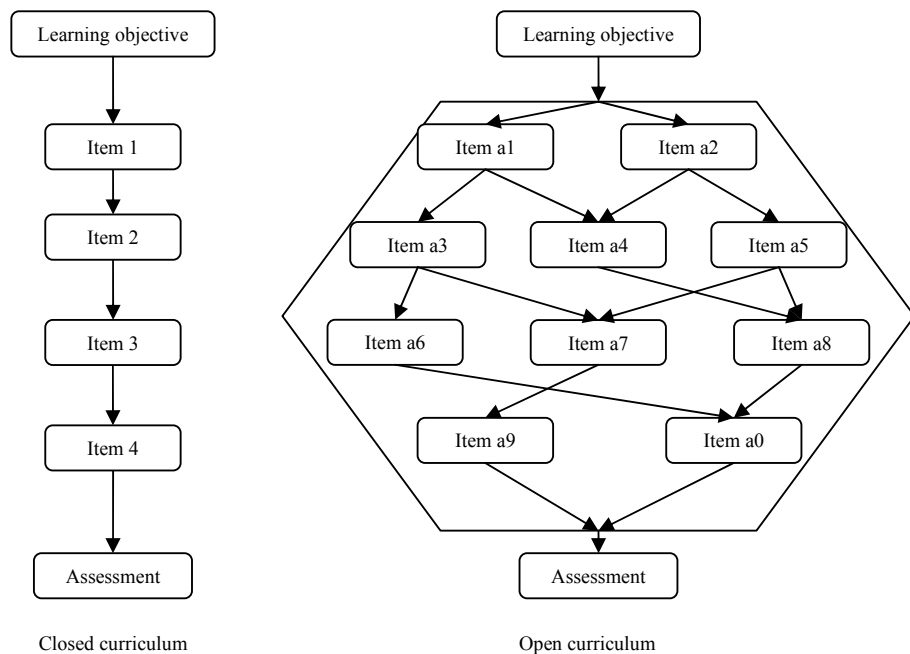


Figure 3 Mapping of the open and closed curriculum onto the SCORM SN

4. Further Work

Generally, performance management systems are difficult to be implemented. The main concerns result from intellectual property issues, and control in the organization. Conversely, if such systems are implemented they undoubtedly serve and support personal development, although performance rating may cause opposition. Problems arise when components and user interfaces lead to a cognitive overload by the employees, especially when there is a missing understanding of goals and how they can be achieved on both, the individual, and the organizational level.

Performance management processes are closely related to competency management processes, where further development and standardization effort is expected in the future. By providing an objective set of measures, competencies can offer an effective way to determine and measure the performance gains of both employees and teams. By behaviorally organizing and effectively attesting competencies, competency-based salary strategies can support business and individual plans. Additionally, competency management is expected to have significant effect on several application domains such as team management, monitoring and assistance, skills development, skills audit, training needs analysis, etc. As competency management involves not only legacy data, processes and policies but also digital objects and systems, new challenges for standards like SCORM, digital object identifiers, and standards for repositories arise.

Quality management assessment will provide a proper guidance to improve the preparation, implementation, performance, and evaluation of educational services. In general, it is targeted at educational institutes that want to certify the quality of their educational services to be conform to ISO 9001/DVWO and the AZWV approval specifications. It will support trainer, training associations and e-learning educators desiring to self-evaluate and assess the quality and consistency of their training scheme.

The expectation is that widespread acceptance of learning technology standards will foster shared resources among institutions and provide new efficiencies for educational institutions. Therefore, standards will increasingly play a larger role in institutional planning and program development discussions in the near future. A key measure of success is that standards generate an industry.

Some aspects of the proposed framework for performance and quality assessment are being implemented by the Business Area Data Representation and Interfaces, Fraunhofer IDMT, in a project called 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. The implementation of further aspects will continue along with standardization contributions to SCORM 2.0 [4] toward a modular design that allows communities of practice to further extend this emerging standard with functionality and innovations that are important for specific applications. Consequently, a fully SCORM-compliant performance and quality assessment system integration can be ensured.

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