

# Question and Test Interoperability in e-Learning System

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*In this paper we present a question and test interoperability in learning content management systems (LCMS). The Question & Test Interoperability (QTI) describes a basic structure for the representation of question (item) and test (assessment) data and their corresponding results reports. The system enables the exchange of this item, assessment and results data between Learning Management Systems, as well as content authors and, content libraries and collections. The system is focussed on enabling the following functionality: (1) The ability to provide question/item banks to users regardless of virtual learning environment (VLE) deployed by the user; (2) The ability to use question/item banks from various sources within a single VLE; (3) Support for tools to develop new question/item banks in a consistent manner; (4) The ability to report test results in a consistent manner. The key components of the system are: Authoring tool; Assessment engine; Learning management system; Candidate data repository; ASI (Assessment, Section and Item objects) repository; External ASI repository.*

*The main research and design activities are conducted following the Unified Process and using the UML as supporting technology. Using an incremental process provides a consistent way to capture requirements, determine main actors and their goals, capture use cases and create functional models of the system. Object-oriented design will further contribute to build-up a flexible and easily extendable system. Database and XML technologies provide powerful means to store, search, retrieve and share information, which combined with the standardized learning object paradigm enable re-usability of knowledge objects and assessment procedures.*

## 1. INTRODUCTION

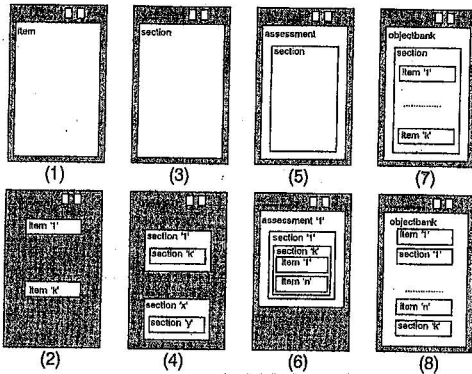
A key element in the learning process is how we can measure its results at organizational, group or individual level. How the introduction of technologies for learning affects the quality of the assessment process is of particular interest to e-learning professionals. Examination of current practice calls into question what is – or should be – the added value of technology for assessment.

There are many authoring systems (ToolBook, SocratEase, Blackboard, WebCT, etc.) which include assessment tools, but all these applications are in English, they are very expensive and have different types of limitations to deploy over the Internet in Bulgarian universities. In response to these problems the authors define requirements and chose architecture for a new Web-based assessment system that is aiming to represent the question and test interoperability in an eLearning system. The Question & Test Interoperability (QTI) describes a basic structure for the representation of question (item) and test (assessment) data and their corresponding

results reports supporting the professional standards (SCORM, IMS, AICC). The architecture enables the exchange of this item, assessment and results data between Learning Management Systems, as well as content authors and, content libraries and collections.

## 2. THE REQUIREMENTS OF THE SYSTEM AND CORE DATA STRUCTURES

The authors focus their attention on enabling the following functionality of the assessment authoring tool: (1) The ability to provide question/item banks to users regardless of virtual learning environment (VLE) deployed by the user; (2) The ability to use question/item banks from various sources within a single VLE; (3) Support for tools to develop new question/item banks in a consistent manner; (4) The ability to report test results in a consistent manner.



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The core data structures that can be exchanged using QTI are shown schematically in Figure 1. The four ASI structures are:

- **Item(s)** – one or more Items can be contained within a QTI-XML instance (Figure 1 – (1) and (2)). The Item is the smallest independent unit that can be exchanged using IMS QTI. An Item cannot be composed of other Items. An Item is more than a ‘Question’ in that it contains the ‘Question’, the presentation/rendering instructions, the response processing to be applied to the participant’s response(s), the feedback that may be presented (including hints and solutions) and the meta-data describing the Item;

- **Section(s)** – one or more Sections can be contained within a QTI-XML instance (Figure 1 – (3) and (4)). A Section can contain any mixture of Sections and/or Items (Figure 1 – (6) and (7)). A Section is used to support two different needs:

- To represent different grouping constructs as defined by the appropriate educational paradigm e.g. a Section could be equivalent to a subject topic
- To constrain the extent of the sequencing instructions and to control the ways in which the different possible sequences may be constructed;

- **Assessment** – only one Assessment can be contained within a QTI-XML instance. It is not possible to define relationships between the Assessments. Each Assessment *must* contain at least one Section (Figure 1 – (5)), thus it is not possible to have Items housed directly within an Assessment. The Assessment contains all of the necessary instructions to enable variable sequencing of the Items and the corresponding aggregated scoring for all of the Items to produce the final score;

▪ **Object bank** – the bundling together a collection of data objects (sections and/or Items) can be labeled as an object bank i.e. a group of Items can be grouped to produce an Item-bank (Figure 1 – (7) and (8)).

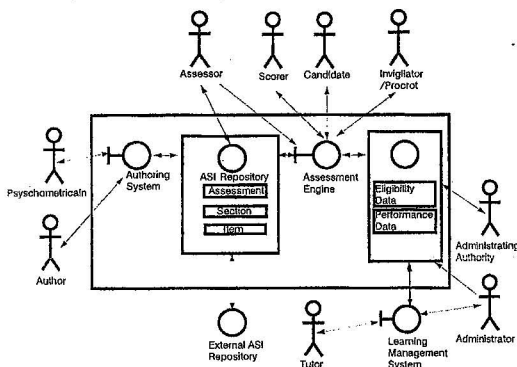
The standard question ten types that will be supported by the assessment system are: true/false choice, multiple choice/response, image hot spot (IHS), fill-in-blank (FIB), select text, slider, drag object/target, ordered objects, match objects, and connect the points can be constructed using a core set of presentation and response structures, and results of questions can be collected and scored by using a variety of methods. The core results reporting data structures are:

- *Result* – the set of results relevant to an actual attempt of an assessment or some other form of evaluation;
- *Context* – the contextual information concerning the actual result being reported e.g. the name, of the participant, participant identifiers, etc;
- *Summary\_result* – the summary information for a particular instance of the evaluation. Each result can contain only one set of summary information;
- *Assessment\_result* – the detailed assessment information for a particular attempt at the assessment. Each result can contain information about one assessment only (this includes descriptions of any contained section and items);
- *Section\_result* – the detailed information about the section(s) completed, or to being attempted. Each result can contain information about one section (this includes descriptions of any contained sections and/or items);
- *Item\_result* – the detailed information about the item(s) completed, or to being attempted. Each result can contain information about one item.

The results reporting components are capable of containing the results from all of the components of an Assessment, Section and Item.

### 3. ASSESSMENT SYSTEM COMPONENTS

The QTI underlying process component (circles), and data structures (thin rectangles), and the participants (stick-people) are shown in Figure 2. They represent



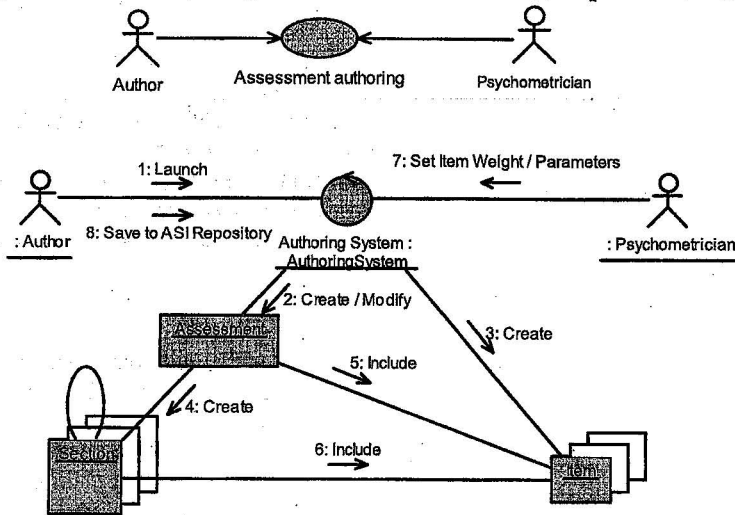
the connection between actors, different applications and ASIs repository. The main actors of the assessment system and their functions are: *author* - creates or modifies ASIs; *Psychometrician* - sets Item weight and parameters in Assessment; *Candidate* - responds to the ASIs and produces a set of responses; *Assessor* - constructs/selects the ASIs to be used throughout the assessment procedure;

*Invigilator/Proctor* - monitors the process of activating the assessment by the Candidate. In addition, the relationships with Learning Management System are shown. The key components of the assessment system are:

- *Authoring system* – the process that supports the creation and editing of the Assessments, Sections and Items (ASIs);
- *Assessment engine* – the process that supports the evaluation of the responses in terms of producing ASI related scores, evaluation and feedback;
- *Learning management system* – the process/system which is responsible for the management of the entire learning architecture;
- *Candidate data repository* – the database of candidate-specific information.
- *ASI repository* – the database of the local ASIs;
- *External ASI repository* – the databases of the external ASI that will be imported through the use of the QTI specifications.

#### 4. USE CASE MODELS

The authoring tool use case model and collaboration diagram shown in Figure 3a and Figure 3b are created using the Rational Rose CASE (Computer-Aided Software



Engineering) system. Main actors of this system are the Author and the Psychometrician. The sequence of processing, with respect to the ASI data structures is:

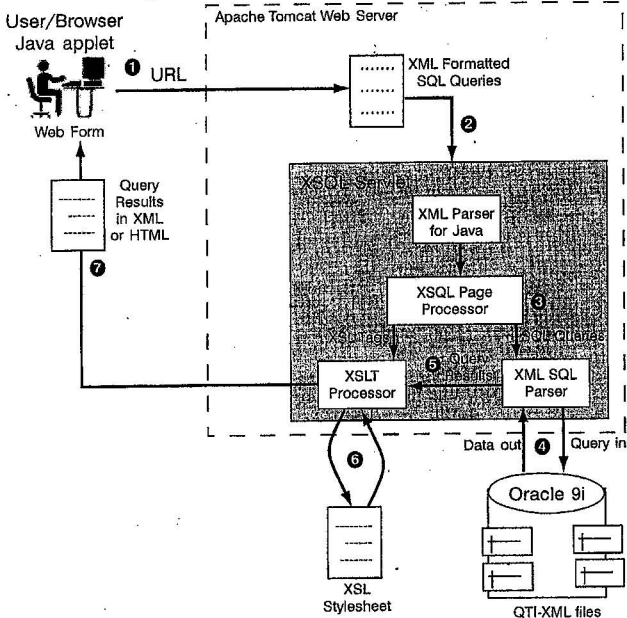
- The Author launches the Authoring System;
- The Author then creates, or modifies, *Items*, *Sections* and/or *Assessments*. These are then exported using this QTI specification and stored in some external

database. The ASI data structures can consist of complex groups based upon multiple *Assessments* and/or multiple recursive *Sections* and/or multiple *Items*;

- The Author may import ASIs that will be used to create the new ASIs. These imported ASIs will also conform to the QTI specifications;
- One of the key responsibilities of the author is to determine the response-type and to map this to the appropriate rendering type. This mapping will depend upon the educational objective of the Item. Similarly, the Section and/or Item groupings, selection and ordering will be dependent upon the educational objectives of the ASI unit.

## 5. AUTHORING TOOL AND CLIENT/SERVER ARCHITECTURES

The client/server system architecture in Figure 4 shows how data flows from a client, to the Oracle XSQL Servlet and database, and back to the client browser for



presentation to the user. The XSQL Servlet is the tool that processes SQL queries and serves the results over the Web as XML datagrams, or HTML pages using server-side XT engine and a specified XSL Stylesheet. The processor is implemented as a Java servlet and takes as its input an XML file containing embedded SQL queries. It uses XML Parser for Java, XML-SQL Utility, and the Oracle XSLT engine to perform its operations. On the Client side we will develop Authoring tool as a Java applet to create or modify ASIs. The new tests will be stores and retrieved from the Oracle database in XML format.

The numbers on Figure 4 represent the sequence of events when the user makes a query to the database. The assessment, section and items objects will be packed in XML format to promote the widest possible adoption. XML is a powerful, flexible, industry standard markup language used to encode data models for Internet-enabled and distributed applications.

## 6. CONCLUSION

The chosen Internet-based client/server architecture and the developed models will serve as a basis for the implementation of the Assessment Authoring system. The object-oriented design and the development process will enable the flawless deployment and future improvements of the system.

## 6. REFERENCES

- [1] Shoikova, E. eLearning Technology, Summer School for Ph.D. Students, Sep., 2002.
- [2] Буча, Г., Rational Rose 2000 and UML. Визуальное моделирование, М., ДМК Пресс, 2001.
- [3] Ravet, S., P. Chevalier: "Assessment in an e-learning environment", The Newsletter of the PROMETEUS Network, September 2002, pp. 2-6.
- [4] IMS Question & Test Interoperability: ASI Information Model Specification, ver. 1.2, IMS Global Learning Consortium, Inc., 2002.
- [5] IMS Question & Test Interoperability: ASI Best Practice & Implementation Guide, ver. 1.2, IMS Global Learning Consortium, Inc., 2002.
- [6] Oracle 8i Application Developer's Guide - XML, Release 3 (8.1.7), Oracle Corp., 2002.