

ADVANCES IN TECHNOLOGY-BASED EDUCATION: TOWARDS A KNOWLEDGE BASED SOCIETY

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ARCADE ASSESSMENTS FRAMEWORK

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The boom in development of learning management tools in recent years stimulates creation of relevant standards, while acceptance of such standards helps system interoperability worldwide. The paper aims in presenting an assessment framework based on the recent IMS standards and built into ARCADE - Architecture for Reusable Courseware Authoring and DELivery. The information model of the assessment tool has been designed with a view to efficient test authoring, management and evaluation of student performance. Its system architecture described here follows principles for strong separation of test's content from the management and evaluation structures making possible an easy and effective preparation, management and customization of tests. The assessment system has been applied successfully into the university teaching process proving its essential benefits as an excellent tool for test control and automatic evaluation.

1 Introduction

ARCADE (Architecture for Reusable Courseware Authoring and DELivery) is a Web based learning management platform targeted to supply e-learning process at universities, schools and organizations supporting education services. The project aims in developing a flexible e-learning portal offering authoring and delivery of Internet-based distance courses and a full suite of services that support collaborative training sessions. In order to achieve these aims, ARCADE was designed as a modular architecture and has been developed in a platform independent way. ARCADE design and development has been grounded on several principles [1, 2]:

- The Unified Software Development Process [3] has been used to define the system scope and business cases including detailed UML-based design [4], implementation and test;

- There have been applied the best known standards and specifications in the area of computer-based distance learning (such as IMS, XML/XSL, LTSC LOM, etc.) in order to provide tool interoperability and possibility for information exchange with other learning management systems (LMS);

- ARCADE is built by standard Internet technologies like Java™, Java Server Pages™ (JSP) and JDBC to access SQL databases (Oracle or MySQL) in order to reach an easy cross-platform portability [5];

- Thanks to its advanced multi language support, ARCADE allows an easy addition of new languages. ARCADE version 2.0 comes in four language versions (English, German, French, and Bulgarian).

The ARCADE LMS consists of five main modules presented in [2]. The paper presents in details an assessment framework used inside the ARCADE assessments and assignments module, and its usage.

2 Design of Assessment Information Model

2.1 Standards for assessment interoperability

Nowadays, the growing online learning community poses a lot of requirements to modern LMS. When building a high-quality assessment system as a part of an integrated LSM, designers must allow LSM users to do the following [6]: authors - to build online learning content; administrators - to manage and distribute content; and learners - to interact with and learn from the content. The IMS Question & Test Interoperability (QTI) specification describes a basic structure for the representation of question (item) and test (assessment) data and their corresponding results reports. Therefore, the specification enables the exchange of this item, assessment and results data between Learning Management Systems, as well as content authors and, content libraries and collections [7]. The QTI specification is given by IMS in XML format and, thus, it promotes widest possible adoption [8]. It is extensible and customizable in order to permit immediate start-up for any type of systems. Like all IMS specifications, it does not limit product designs by specifying any interfaces, paradigms or technologies.

According QTI, a test is an instance of an *Assessment*. Assessments are assembled from *Items* that are contained within a *Section* to resemble a traditional test. Moreover, Assessments might be assembled from groups of *Items*. The *Items* should be logically related and are called *Sections* [8]. Thus, Assessments are composed of one or more *Sections*, which themselves are composed of *Items*, or more *Sections*. In figure 1

there are presented the goals of IMS learning consortium, which includes members from educational, commercial and government organizations.

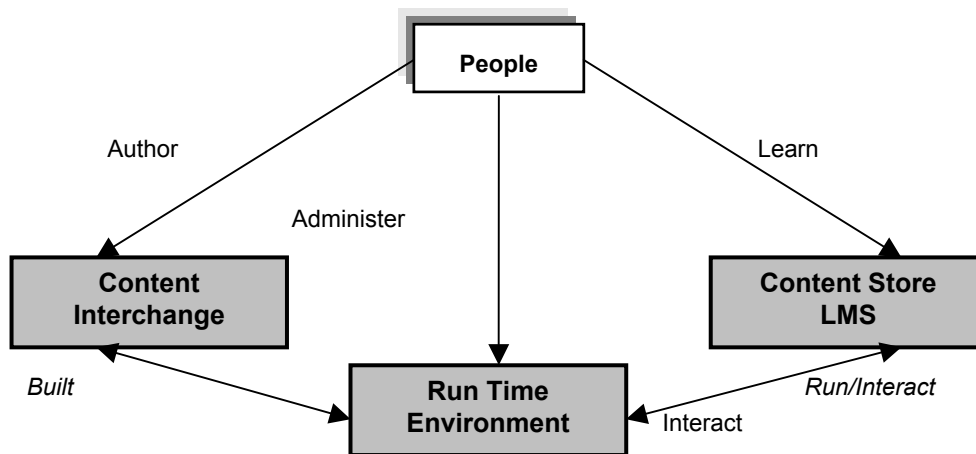


Figure 1.
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Data Model

After reviewing couple of commercial assessment systems [9, 10] and resolving to use QTI specifications, a common framework has been accepted for the ARCADE assessment module. The data model of the ARCADE assessment framework is presented in figure 2. The ASI (Assessment Section Item) structures show the three main data objects that build tests and assessments. There are some specific meanings of these structures. Each of the ASI structures designed in ARCADE system has a parent data object. And all objects inherit common properties from one abstract data class called ASI Object. Its main properties are name, version, description; parent object id and parent object type. Data entities can be divided by their usage in three different sub-packages:

❖ Authoring related structures

- *Assessment* – represents assessment data object (also called test). Its main properties are name, description, version, copyrights note, duration, control style, item count, and status. There also editors and permission fields. Actually assessment is top-level element (or so called root) for all ASI substructures. Assessment contains one or more *Sections data objects*. Its parent data object is ASI Author object (actually it is not class from the assessment data structure) and can be changed in further releases with changing type of parent object;
- *Section* – is grouping data object. Its properties are field contains parent assessment id, name, description, version, duration time for current section, control style and item count. Each section can contain other sections or items. Section which parent ASI Object is Section is called *nested* section. Section is not widely supported, but is introduced for future use and compatibility with QTI specifications. There are only couples of minor appliance of the section and none for the nested sections;
- *Item* – is data object that represents item object. For Item can think as a question. But more precise definition can be given: item is question or group of questions, which logically answered to one general question. It is smallest independent data structure exists as standalone object. Item can be very simple object or very complex – it depends on the underlying objects. Its important properties are name, description, version, item type, max time (for evaluation of current item), render type, max score and scoring type. Currently is supported only average scoring algorithm;
- *Knowledge Atom (KA)* – it is (as its name says) the smallest unit, which represents some kind of information. There is support of visual information – information knowledge atoms (such as text and images), grouping information – *grouping* knowledge atoms and *formatting* knowledge atoms. To implement such wide range of data types here is used data sub typing in large limits. The most important properties of knowledge atom data structure are name, description, version, information (text material or image URI), information type (text, image), type of knowledge atom – question or answer, response format – yes/no, multiple choice, fill-in-blank or essay, response type (whether is grouping or information type; for now third type is not supported – formatting type), response group name – groups answers in groups, providing abilities for complex questions, score (for

answer), max time, mandatory, style and two properties, which contains addition information depends of other fields.

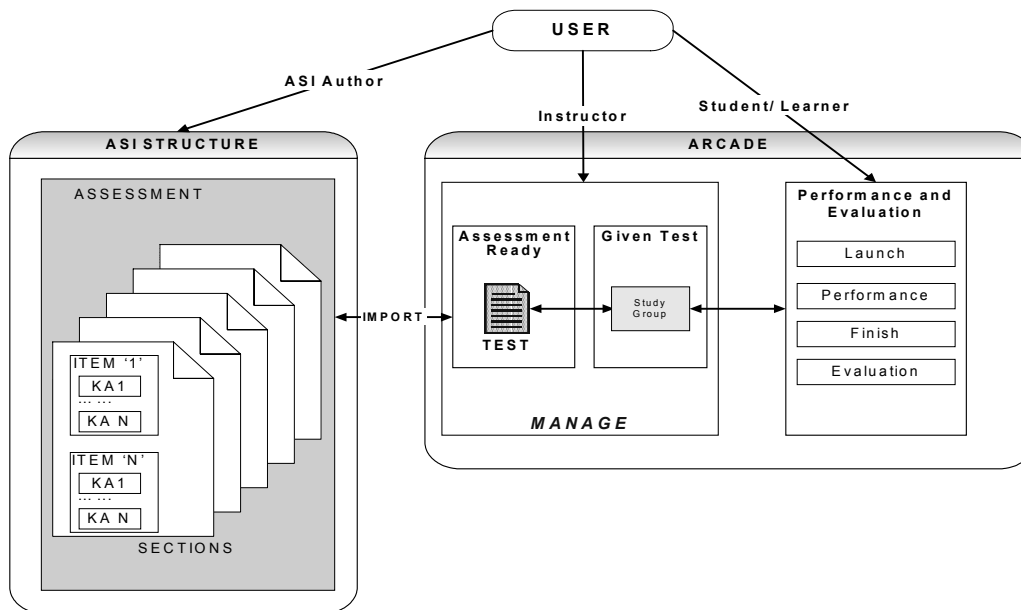


Figure 2. ARCADE Assessment Framework Model.

- ❖ Test Management related structures:
 - *Assessment Ready* – this data structure is designed for future releases when support for different levels of readiness of the assessment will be supported; property of this type of assessment is parent assessment;
 - *Test* – it has properties name, description, parent assessment, start and end dates, test policy and test evaluation limits, access type, stack holder reference and type of test. Test can be defined as general instance of assessment (with many questions);
 - *Given Test* – represents test instance of test but for one student. In fact result from evaluation process (scores) is for one given test. Given test generates as random subset of questions in parent assessment of the test. Important properties here is also student id, course id, start and end date, time limit (for all test), and page size.
- ❖ Performance and Evaluation related structures
 - *Answer Sheet* – this data object collects data from evaluation process for one given test. This object is very important for import/export of result sheets of the students. Every test can be evaluated in one system and can be evaluated and scored in another system that supports QTI specifications.

3 Assessment System Architecture

ARCADE is a Learning Management System that provides Web-based courses with common delivery framework. It incorporates wide range of facilities for effective and efficient learning. Assessing student performance is one of the most important activities in learning process and not only. In fact there is no need to participate in learning course to use assessments to evaluate students' knowledge. The architecture of ARCADE includes five main packages: *User and System Management*, *Course and Curriculum Management*, *Authoring tool*, *Tasks* and *Communications* [1]. Each of these packages includes other sub packages. *Figure 3* represents position of assessment module and its sub-modules - *ASI structure authoring*, *test management*, and *performance and evaluation*.

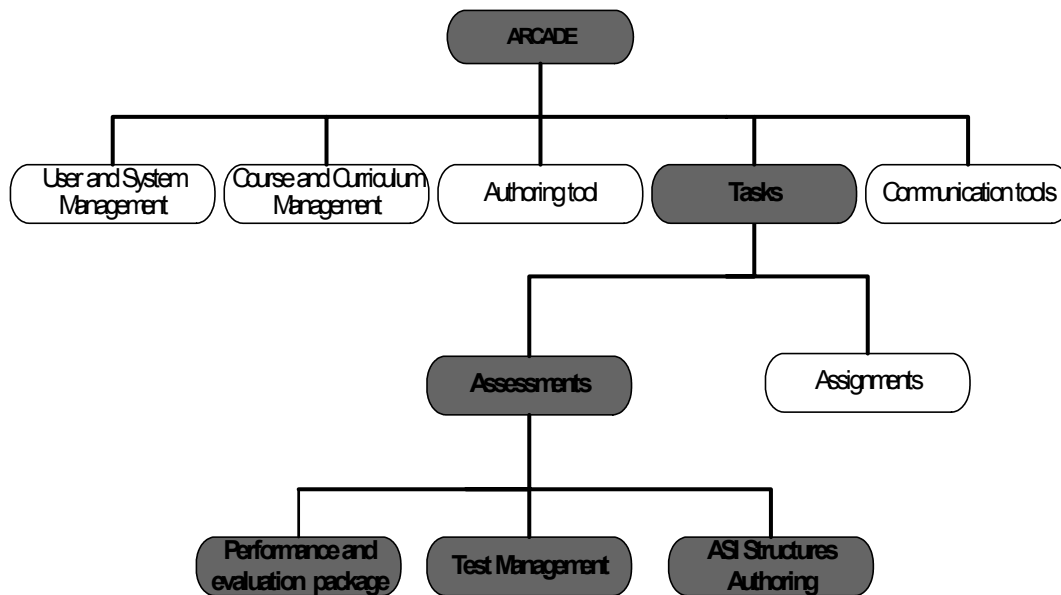


Figure 3. ARCADE packages diagram.

More detailed user oriented review of features are given at next section but short description of the assessment sub packages, ordered by time of activity is:

- ❖ *ASI structure authoring* – supports design time of assessment preparation – it gives opportunities to create, refine and manage wide range of ASI structures and learning objects. There is question import utility tool as part of this sub-package. It supports couple of different questions formats. This tool is important for off-line test development, because there is no need of sometime expensive internet connection.
- ❖ *Test management* – supports pre- and post- evaluation process activities – such as preparation, management and customization of tests including random selection of a subset from all the test's questions and its permutation. The assessments are tailored to needs of particular course (pre activities). More, there are supported evaluations and custom feedbacks (as post activities).
- ❖ *Performance and evaluation package* – manages and supports run-time part of the evaluation process: it allows everyone who participates to the ARCADE system as *student* to evaluate tests, which are managed by the *instructor* of the course.

4 User Functionalities o Arcade Assessment System

One of the unique aspects of the Assessment Framework is the modular separation of the ASI structure authoring, test management, and performance and evaluation modules. The main benefit is separation of the work of author from the test and evaluation system. The structure authoring is used by *ASI author* to create *assessments*. The test management module used by *instructor* to create *tests* and give them to *students*. A *test* is automatically generated based on the *assessment* usage. The *instructor* determines all needed test's attributes and set the points of correct and uncorrected answer. Then the instructor can assign (give) test to student. In figure 4 you can see the process of assign test to student.

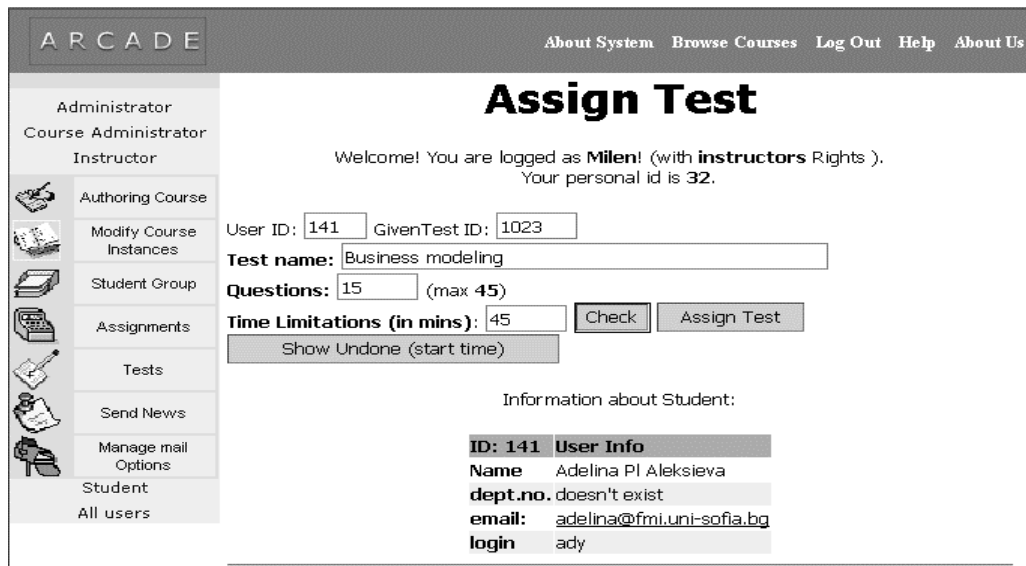


Figure 4. Assign test to student in ARCADE Assessment System.

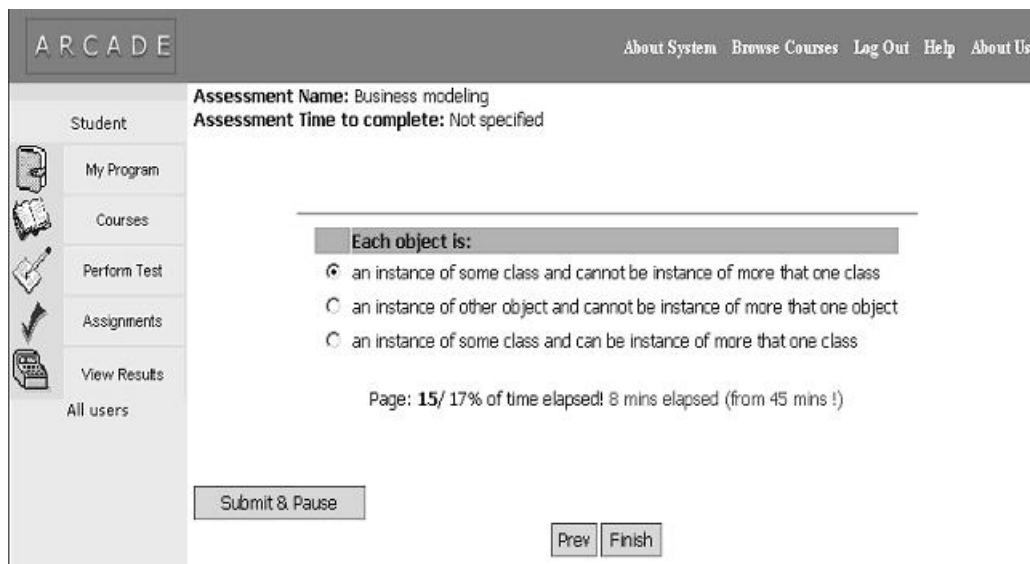


Figure 5. One-of-many type of question during evaluation process.

Once received the test, the student can perform it. There is different kind of questions, based on term item specified in IMS specification, like: multi-chose, single chose, fill-in-blank and questions type essay. The first three questions can evaluated automatically. Figure 5 shows a screen of test performing process. The performance and evaluation modules provide evaluation support for different kind of questions, based on the term *item* specified in IMS specification. When a student finishes a test, he/she can view an answer sheet with all questions and answers.

5 Discussion

In recent years, there are more and more proposals for e-learning management systems - from formal models to operational environments. The ARCADE platform appears as a natural consequence after many years of study and practical experience with LMS models and has been strongly encouraged by the newly development of standards in the area. Its assessment framework has an information model based on the IMS Question and Test Interoperability specification and, thus, it is conformable to other QTI based tools. During the latest experiments with real student tests, it has been proven the framework does support real-time assessment of student performance in an effective way. The automatic evaluation and custom feedback support turn to be essential for a well-controlled and effective e-learning process.

After the assessment module and the ARCADE platform as a whole have been proven to be viable and very suitable for extensive usage in real teaching processes at the Department of IT at the Sofia University, we plan future enhancements of the assessment framework presented here¹, namely:

- ❖ Creation of more advanced means for automation and control of the tests, and for viewing statistics about the student performance;
- ❖ An authoring tool for creating tests (ASI structures with learning objects), which will substitute the questions' import utility tool currently used;
- ❖ Tools for creating and controlling adaptive courseware.

The ARCADE team truly believes the created learning management system provides powerful means for an effective e-learning at with low cost-performance ratio. Its interoperability, openness and easy maintenance make it appealing for universities, schools and organizations providing teaching services.

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¹ More information can be found at the ARCADE Web site at <http://www.e-arcade.net>