description of comprehensive calculation of gears and it helps the learners study course of theoretical mechanics for technical universities independently and to solve engineer's problems on computers.

DTS on theoretical mechanics passed evaluation test in the teaching process at Astrakhan State Technical University in 2003 and it showed a good performance.

Problems of program realization were solved when developing DTS. They include the following:

- format choice with due account of their mutual compatibility and opportunity of transfer over Internet;

- choice of compliant software and realization of technological chain development of DTS;

- possibility of providing local and distance operation with appendixes;

- providing of textbook updating, adding new teaching material in particular. In the future it is presumed to develop an integral distance information environment on a mechanical type worked out on the base of DTS, an environment, where it is possible to form an integral array of knowledge elements (such as mechanics) and to realize dynamic access for reference data on various specialties.

Apart from reference and teaching theoretical material there will be provided model opportunities, control functions and administering.

Bibliography

[Pavlovsky, 2003] Pavlovsky V.E., Nevenchannaya T.O., Kurganskaya G.S., Ponomaryova E.V., "Concept, structure, program realization of electronic Internet-textbook: preprint IAM M.V. Keldysh RAS; №39, M., 2003, 28 p.

[Nevenchannaya T.O., 2003] Nevenchannaya T.O., Pavlovsky V.E. Ponomaryova E.V. "Integrated calculation of mechanisms in electronic textbook on theoretical mechanics»: Preprint M.N. Keldysh IAM RAM, №38, M., 203, 24 p.

[Matrosov, 2001] Matrosov A.V., Maple 6. "Solving of problems on higher mathematics and mechanics". B.P.b.:6. LXB. Petersburg, 2001, 528 p.

Authors' Information

Elena Ponomaryova - Astrakhan State Technical University, Associate Professor; P.O. Box: 414056, Astrakhan, Taticheva, 26, app. 53, Russia; e-mail: acmpax@rambler.ru

Tatiana Nevenchannaya - Astrakhan State Technical University, Professor; P.O. Box: 414025, Astrakhan, Taticheva, 16, Russia; e-mail: nevento@rambler.ru

Vadimir Pavlovsky - The Keldysh Institute for Applied Mathematics, Russia Acad. of Sci., Professor; P.O. Box: 125047, Moscow, Miusskaya, 4, Russia; e-mail: vlpavl@mail.ru

DESIGN STANDARDIZED WEB-COMPONENTS FOR E-LEARNING

Andrey Belonogov

Abstract: In this paper a flexible approach to design LMS with QTI Ready component based on the e-Learning standards AICC and IMS QTI is described. This system and component permits a dynamic learning and assessment process. QTI Ready component can provide these facilities to other real world virtual learning management system.

Keywords: Web-based education, e-Learning technologies, metadata schemes, standardization and open standards, Servlet technology.

ACM Classification Keywords: D.2 Software engineering – Standards: D.2.11 Software Architectures - Patterns (e.g., client/server, pipeline, blackboard); H.3.5 Online Information Services - Web-based services

Introduction

Designers of online learning systems have an enormous variety of software tools and learning resources at their disposal. Unfortunately, the wide variety of software tools available from many different vendors is not able to share learning resources and interoperate with each other. Nowadays, Web-based education research efforts are focused into the standardization of learning metadata schemes, course structures and software interfaces to provide interoperability between applications and learning resources. This would allow both instructors to reuse learning resources and developers to reuse educational software.

The learning technology standardization process is taking the lead role in the research efforts into Web-based education. Standardization is needed for two main reasons: on the one hand, educational resources are defined, structured and presented using different formats; on the other hand, the functional modules that are embedded in a particular learning system cannot be reused by a different one in a straightforward way.

Standardized definitions for course structures are necessary to move courses from one system to another. In a similar way, learning management environments need to understand the course structure to schedule the next student activity. They propose a Web-based run time environment scheme based on the division between the learning contents and the Web-based management system that launches on the browser, delivers through the network and controls them. This allows different learning resources to be managed by heterogeneous management systems.

The objective of this project is to develop advanced program system that helps improve access to Europe's knowledge and educational resources via e-Learning technologies.

The Web application framework to build Learning Management System (LMS) "xDLS" for small educational organizations and components of this LMS are presented. It is demonstrated how frameworks services can be configured to create a complete system. This framework increases reusability and reduces the maintenance requirements of the LMS. It provides a way to develop the Web component "QTI Ready" which allows to edit and play QTI based quizzes and tests. This component already can be used in many of existing VLE (Virtual Learning Environment).

Methodology

The system xDLS combines the latest Internet and database technologies, incorporating a user-friendly and intuitive interface; xDLS raises the industry standard in Web-based testing. Flexible and powerful enterprise architecture of the system permits to effortlessly incorporate xDLS into new or existing training programs. The system is based on Java technology.

The package QTI Ready is the server side J2EE component for operation with tests in IMS QTI format. The package is realized on the Servlet technology with independent platform. Interaction of the package with Web-application is carried out extremely through the protocol atop HTTP protocol. XSL + XML technology is used for generating HTML pages. The relational database is the storage of resources and system information.

Technological Description

In this section two software products, developed by the author, supporting standard IMS Q*TI are described

xDLS Learning Management System

The system xDLS is Web-based enterprise-wide Learning Management System. xDLS software resides on a server, allowing to access it via a Web browser. It also allows teachers to make changes to quizzes readily – from any Web-accessible location – and to make these changes available to your students immediately.

The system xDLS can be used to

- evaluate students with quizzes,
- provide assessments that include text, html, image, flash,
- integrate Web resources.

Authors can create, modify, delete and rearrange questions in assessment with ease. The system resources are complied with open standards such as the IMS Project Question and Test Interoperability (QTI) Specification. The system provides several types of questions (multiple choice, multiple response, matching, numerical and string

fill-in-black). Assessment data can be exported and imported in zipped file according to IMS QTI specification. Image and HTML materials are supported.

It is proposed to organize questions in accordance with the Question and Test Interpretability's ASI (Assessment Section Item) model provided by IMS Global Learning Consortium, Inc. According to this model every assessment is divided into several sections and each section consists of several items. An Item is the smallest object needed for the assessment, which represents generally a question, defined as a combination of interrogatory, rendering, and feedback information. The IMS QTI specification will enable to exchange assessment items and results during the learning process.

The system xDLS combines the latest Internet and database technologies, incorporating a user-friendly and intuitive user interface. xDLS raises the industry standard in Web-based testing. Flexible and powerful enterprise architecture of xDLS permits to effortlessly incorporate xDLS into new systems or existing training programs.

The xDLS key features are listed below:

- Pure HTML based, no Java or Flash needed (unless your content does need it).
- "No frames" solution.
- Multilingual (currently available in Russian, English and German).
- Printview with optimized printing template (without menus or decoration) and optimized font.
- The course editor of xDLS allows create new courses within short time.
- Advanced enrollment system (self enrollment in groups, management of available seats).
- Advanced group management, associating groups to learning areas.
- Support for self organized learning/collaborative work via so-called buddy groups: everybody can create his own group and work together with his peers.
- Testing system with various testing types (Multiple Choice, Single Choice, Fill in blank), fully based on IMS QTI v1.2.
- Score based course system: score can be fed automatically (by online tests).
- Personalized task management.
- Questionary/Survey system, fully based on IMS QTI v1.2.
- Publishing and access management for learning content via the learning resource repository module.
- Easy backup files via ZIP compression.
- 100% Java based, only tomcat and a relational database required (tested with MySQL).
- Unlimited number of learner.
- Unlimited number of courses.

QTI Ready

Package QTI Ready is the server side J2EE component for operation with tests in IMS QTI format. QTI Ready is meant to do only one thing – to edit and play QTI tests. One other notable characteristic of QTI Ready is that it makes relatively few assumptions about a user's machine; playing and authoring tests happens on the server, and the result is rendered as HTML. So no plug-ins is needed, and no major restrictions on hardware or operating system beyond the ability to run a decent browser. It also simplifies authoring tasks by separating the roles of the layout designer and content author. In addition, it gives user the flexibility to view any content using any defined layout as well as to add annotations to the content.

The process of testing and editing is realized in Web-interface that can be easily customized. Export and import IMS QTI tests is realized through loading and uploading ZIP files.

Package QTI Ready consists of two components:

- QTI Ready Player (QRP) provides Web based test and survey delivery capabilities via HACP AICC protocol. Upload a QTI compliant questionnaire into a QTI Ready test server, launch it via AICC URL, take a test, and see your results recorded into your Learning Management System.

- QTI Ready Designer (QRD) provides Web based test and survey authoring capabilities and generates IMS QTI compliant tests and questionnaires with saving them on the server.

Package QTI Ready can be applied to extend the learning management system of remote training and to design test portal.
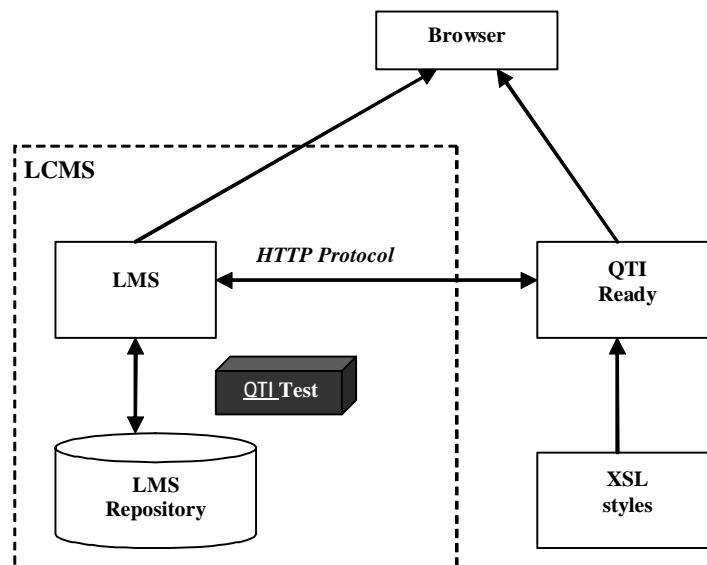

Figure 1. The QTI Ready Component Integration

Interaction of the package with Web-application is carried out extremely through the protocol atop HTTP protocol (fig. 1) that provides:

- possibility of integration with Web-application realized on any Web-technology: Java, Perl, PHP, ASP etc.; (If your server application is not based on Java technology it's enough for you to install Open Source Tomcat server);

- complete independence from system environment: operating systems and DBMS;

- allows centralized data storing.

The VLE can communicate with the QTI Ready authoring tool and player via the AICC HTTP based API (HACP). HACP is an older specification about sending commands from learning content to a VLE via encoding in URIs, which is considered to be pretty unsafe these days. The URIs can be fairly easily grabbed and tampered with on the way. On the plus side, it does not have the cross-domain scripting problems associated with AICC's newer sibling, SCORM.

For those security reasons, the HACP communication between a VLE and the QTI Ready player is limited to selecting and starting a particular test, and signalling when the test is done. The actual score calculation is done on the server side, from a Web form. This makes it less easy for the test results to be tampered with on a user's browser, but, since forms are even easier to grab than URIs, following QTI Ready's advice to use it over a secure HTTPs connection seems wise.

Package is realized on Servlet technology with independent platform and can be easily built in indirect web-application to accessible Servlet container.

Using of XSL+XML technology in generating HTML pages makes user interface customization very simple. There are several types of preformatted user's XSL styles for setting up user interface.

Plug-in supports several languages of user interface simultaneously. The language of the interface for curtain user can be set up while the program is running. Also, it is simple to add a new language.

QTI Ready Player – Web-plug-in, which can play tests stored in repository of Learning Management Systems. Tests are stored in external repository as ZIP archives. This archive contains XML file in IMS QTI format plus resource files used in the test. For Learning Management System format of the test is possible to consider as black box, all functionality of operation with these tests will be carried out by package QTI Ready. QTI Ready loads the test from repository once and returns results via AICC protocol.

There is no limitation for internal structure of tests' repository. It can be the relational database, in Blob fields of which ZIP files will be stored, or simple catalogue of the file system. Access to the tests by plug-in QTI Ready Player is carried out through HTTP protocol or the same way as to local files.

QTI Ready Designer (QRD) provides Web based authoring tool designed specifically to create surveys, tests, and assessments. This component generates IMS QTI compliant questionnaires.

QRD key features are listed below:

- Easy to integrate into any Web based learning management or survey administration system through HTML based API.
- Produces QTI compliant questionnaires.
- Packaged as J2EE Web Application.
- Easily customizable XSLT based user interface.

To set up QTI Ready Designer it will be necessary to store repository of the tests analogue to repository for QRP. Tests may be stored in the same form of zip archives. In addition to ZIP files it is required to store the set of attributes for each test. For editing test QRD loads it to the temporary local storage. Test will be uploaded to the repository of Web-application obviously when command about export of the test is given from QRD. Also in Web-application it's possible to organize the implicit load of test from temporary storage. If the user quits editing the test, without having made export of the test, then by the time of the next session the test will be given in that state, in which it was left.

Generation of HTML is executed on the server using XSL+XML technology. For setting up user interface it is recommended to customize user's styles where descriptions of general units of external interface is stored.

Conclusion

The system xDLS is used in more than 10 organizations in Russia (Moscow, Siberia and so on) and Ukraine. The package QTI Ready is integrated with xDLS. Package is tested on following Servlet containers: Tomcat 3.3, 4.0, 4.1,5.0, JRun, Orion Web Server.

The system easily was adapted for requirements of users. It allows to execute integration with existing systems or to create on its basis a new system in the shortest terms.

The current IMS QTI standard version does not provide a possibility to adaptive testing. Author would like to continue experiments with the all offered assessment types by IMS QTI and to investigate also more complex sequencing types to offer a more precise and faster marking process, as well as a timely feedback. This enables to provide the learner with a wide range of assessment possibilities, to permit a dynamic learning process based on an accurate evaluation of knowledge level.

Bibliography

IEEE PAPI. IEEE P1484.2.5/D8, 2002. Draft standard for learning technology. Public and private information (papi) for learners (papi learner). Available at: http://jtc1sc36.org/doc/36N0179.pdf

IMS Global Learning Consortium Inc. IMS Question and Test Interoperability ASI Information Model,2004.V1.2.Available at: http://www.imsglobal.org/question/qtiv1p2/imsqti_asi_infov1p2.html.

IMS Global Learning Consortium Inc. IMS Question and Test Interoperability Results reporting, 2004.V1.2. Available at: http://www.imsglobal.org/question/qtiv1p2/imsqti_res_bestv1p2.html .

IMS Global Learning Consortium Inc. IMS Question and Test Interoperability Specification, 2004,Version 1.2. Available at: http://www.imsglobal.org/question/index.cfm.

LTSC Learning Technology Standards Committee, Learning Object metadata standard, 2004. Available at: http://ltsc.ieee.org.

[Cheryl, 2001] G. Cheryl. XML: New Formula for e-Learning. 2001.

Authors' Information

Andrey Belonogov - Perm State University, Post graduate student of the Department of Computer Science; PSU, 15, Bukirev St., Perm, 614990, Russia; e-mail: abelon@perm.ru