

Automated e-learning quality evaluation

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Abstract: *The quality assurance and evaluation of e-learning is of high priority for any up-to-date higher educational institution. The paper is devoted on automation of related processes on the basis of a modern approach for integration of heterogeneous software systems. It presents the context, substance and objectives of a study related to the automated data retrieval in e-learning quality evaluation. It describes two specific experiments on such integration for e-learning quality evaluation in terms of students' satisfaction and in terms of compliance with appropriate quality standards.*

Key words: *System Integration, Service Oriented Integration, e-Learning Quality Assurance, Automated e-Learning Quality Evaluation.*

INTRODUCTION

Quality(evaluation) being a key instrument of quality assurance and quality enhancement in higher education (HE) is one of the most typical components of the Bologna process.

Since e-learning technology is becoming an integral part of contemporary learning activities in all learning modes offered by higher educational institutions, hence the evaluation of e-learning quality is assumed as a top priority.

The monitoring, control and evaluation of the e-learning quality are key elements of more and more institutional and national quality systems (i.e. internal and external evaluation) of HE in Europe (e.g. Norway, Sweden, Great Britain, Bulgaria). The majority of the academic community understands the importance of this issue – something demonstrated by the large number of publications on the topic. Various experiments have been conducted to evaluate the quality of e-learning in the terms of its various components (like learning outcomes, learning process, academic staff, learning materials and activities, infrastructure, students satisfactions, etc.), based on different relevant quality models and standards (e.g. Context-Inputs-Process-Product of Stufflebeam, Reaction-Learning-Behaviour-Results of Kirkpatrick, etc.).

Interesting examples in this field are the suggested models and approaches for quality evaluation of e-learning: as a whole – in terms of planning, development, process and product [8]; of the e-learning environments from the students' perspective [5], of the electronic educational resources [7], of the learners' satisfaction (including learners with special educational needs) [6] etc.

Another extremely discussed aspect of e-learning quality assurance and evaluation is the need of automation of its related processes. The fact that the automated approach is typical for this form of education logically implies the conclusion that it is appropriate to use automated tools in evaluating its quality. This is the only possible manner to use effectively and in full degree all the data that have been collected and stored in electronic format during the organization and conduction of the e-learning.

The paper is dedicated namely on this important aspect of the subject. It presents the context, essence and the purposes of a study on a modern approach for integration of heterogeneous software systems and its application for automated data retrieval in e-learning quality evaluation. Two specific experiments are described, carried out during this study, with regard to such integration for e-learning quality evaluation in terms of students' satisfaction and in terms of compliance with appropriate quality standards.

AUTOMATED DATA RETRIEVAL IN E-LEARNING QUALITY EVALUATION (CONTEXT, ESSENCE AND PURPOSE OF THE STUDY)

Regardless of the needs for evaluating the e-learning quality, no matter whether for internal or external evaluation, or for HE quality assurance and improvement, it is based on the respective criteria and regulatory procedures. Usually such criteria systems (quality

models) are very detailed and include a large number of evaluation criteria. For example, the Swedish ELQ model for HE e-learning quality, consists of ten quality aspects, in relation with which a total of 33 distinct criteria and 12 sub-criteria are evaluated while in Bulgaria, the criteria system for evaluation of distance study programmes includes 46 quality indicators.

The quality evaluation, applying such standards, requires the collection, analysis and interpretation of a huge amount of data in terms of learning materials used; infrastructure; e-learning environment; tools and intensity of communication, cooperation and interactivity; the application of a student assessment system; flexibility and adaptability of the learning process; student and faculty support; team qualification and experience, etc.

On the one hand, the above is an argument for the automation of these activities. But on the other hand, it poses a number of problems – it requires extraction and processing of data from different information systems, which are often based on a different server, operating system, communication platform, database etc. These problems are essentially related to the need of integration of heterogeneous information systems.

Similar problems completely affect not only quality assurance, but also all aspects of the automated information servicing of a typical university and of all various activities necessary for the implementation of educational, management and administrative functions of the institution as such.

The paper presents some of the results of a study, which aims to apply the advantages of the modern approach for integration of heterogeneous software applications, called Service Oriented Integration, in the field of HE.

The idea (fig. 1) is to apply the typical software architectural model Enterprise Service Bus (ESB), based on Service-Oriented Architecture (SOA), to the integration of university information systems. In accordance with the model, each university software system is represented once by the relevant Web Services and is integrated into the so-called "Integration Service Bus". It allows the combination of these lower level services into higher level business services by the Business Service Bus, so that they adequately meet different new requirements, initiatives or changes in the information servicing of the university.

In order to improve visibility, without any loss of generality, the scheme shown in fig. 1 reflects only the part of the studied architectural model which is of interest to the HE aspect under discussion in this paper – e-learning quality evaluation. The scheme illustrates:

- Software applications: Learning Management System (LMS), Centralised system for generating queries and reports and decision making (called University Business Intelligence System – UBIS), other university systems and external information systems;
- Web Services: LMS Services, UBIS Services and other services;
- Business services: Internal Evaluation of a Field of Study (FS), Internal Evaluation of a University Unit, Internal Evaluation of the University and External Evaluation.

So far in the frame of this study a set of the web services necessary to represent the different university systems to the Integration Service Bus has been specified (for some examples see fig. 1). Various experiments have also been conducted on the software implementation of web services, as well as on their usage for integration of different university systems.

Two of these experiments, related to data retrieval from the LMS, aiming to automate the quality evaluation of the conducted e-learning are presented in the following sections of this paper. The results of such evaluation could be used within the framework of different procedures for internal and external evaluation of a university and its educational activity. The precise software systems, used in the experiments, are as follows:

- one of the most widespread open source LMS – Moodle and

- specially developed UBIS, called UBIS-Jaspersoft, based on the popular software Jaspersoft BI Suite, which allows the development of Business Intelligence solutions for organizations of various type, including higher educational institutions.

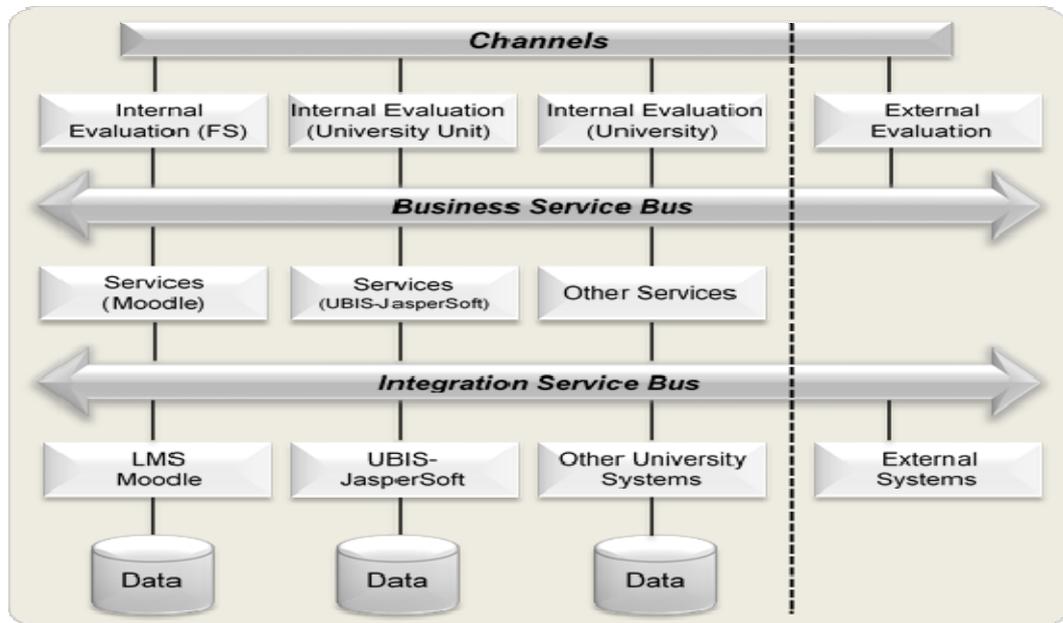


Figure 1. Integration of university information systems

EXPERIMENT: STUDENTS SATISFACTION

The first experiment is related to the integration of UBIS-Jaspersoft and LMS Moodle. It aims to extract, analyse and interpret data about students' satisfaction by the conducted e-learning.

| Course documentation and educational goals | |
|---|---|
| Navigation | <p>1. The learning goals (development of competence, skills and attitudes, learning and skills, training for application of knowledge and skills, etc.) of each learning unit are clearly defined</p> <p> <input type="radio"/> 1: poor (definitely 'no') <input type="radio"/> 2: satisfactory (rather 'no') <input type="radio"/> 3: good (and 'yes' and 'no') <input type="radio"/> 4: very good (rather 'yes') <input type="radio"/> 5: excellent (definitely 'yes') </p> |
| Administration | <p>2. You know in advance the knowledge and skills that you have to acquire in different stages of training and after successful completion of the course.</p> <p> <input type="radio"/> 1: poor (definitely 'no') <input type="radio"/> 2: satisfactory (rather 'no') <input type="radio"/> 3: good (and 'yes' and 'no') <input type="radio"/> 4: very good (rather 'yes') <input type="radio"/> 5: excellent (definitely 'yes') </p> |
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Figure 2. Electronic survey

For studying the students' opinion the typical for each similar quality management system approach is used, namely by conducting a survey. It is accomplished in an electronic form. In order to fulfil this, the Moodle module Feedback is used as a tool for creation of templates with questions that can be further used multiple times. The already created survey template is included as part of the learning activities in each electronic course (e-course) in order to be fulfilled by all the participating students after completion of the training. The electronic questionnaire (see Fig. 2) contains around 50 questions for quality evaluation of the conducted e-course in terms of its different characteristics, such as course documentation and educational goals; learning materials and activities; team for provision; communication; assessment methods; feedback; etc.

Once the questionnaires are completed, the data is stored in the system's database and can be used for analysis of the results through the LMS Moodle module Feedback. The problem that has to be solved within the scope of the experiment is that the built-in module Feedback offers opportunities for generation of summarised and statistical reports about the poll result only within a specific course and its participants.

In order for the obtained data from the survey to be used in accordance with the purpose stated above (at internal and external evaluation in HE), it is necessary to provide automated software tools for the synthesis and analysis of the results at a more general level, e.g. for all e-courses in a field of study or for all e-courses in a scientific field (SF).

In solving this problem, the experiment is carried out in 4 (four) steps using the system UBIS-Jaspersoft and the capabilities of its basic software Jaspersoft BI Suite for creating reports and analyses by retrieving data from different sources, for storing and organizing reports in a repository and for presenting them in the preferred by the user form. Jaspersoft offers powerful tools for integration with various user software applications through shared web services.

In **Step 1** UBIS-Jaspersoft is integrated with Moodle database, which is set as a data source for retrieving of the data from the students' surveys and creation of reports, reflecting student satisfaction. It should be noted that besides to relational databases (such as the Moodle database) JasperSoft can be connected to just about any data source, including JDBC, XML, CSV, Hibernate, POJO etc.

In **Step 2** templates of analytical reports are developed, which can be later used to generate the real reports containing summarised results from the conducted survey or from other similar surveys, related to e-learning quality evaluation.

For templates description JasperSoft supports:

- wide range of tools for visual design and good report layouts, representing data in the form of tables, charts, or crosstabs-based reports;
- a number of scripting languages (Java, Groovy, JavaScript, etc.) for construction of expressions in order to declare report variables, to perform various calculations, grouping data into the report, to specify report text field content, or to customize further the appearance of report objects;
- extensive set of query languages, including SQL, HQL, EJBQL, etc. for retrieving data from different data sources.

In the present case 6 (six) templates are developed. They can be used in automated surveys for the quality of e-courses in a concrete FS or SF in order to obtain summarised information as follows:

- the number of e-courses, in which conduction of the survey is planned (with added questionnaires) by each FS offered in the university training;
- a list of e-courses by the corresponding FSs, in which conduction of the survey is planned;
- the number of e-courses by FSs, where the survey is already conducted (with completed questionnaires);
- a list of e-courses by FSs, where the survey is conducted along with the corresponding number of participants in the survey (number of completed questionnaires);
- summarised results of the survey by FSs;
- summarised results of the survey by the evaluated characteristics of e-courses and by SFs.

The templates include a presentation of the summarized results both in the forms of tables and charts. Fig. 3 shows a screenshot from the template dedicated to generate the summarised results of the survey by SFs during its design.

The templates include a presentation of the summarized results both in the forms of tables and charts. Jaspersoft creates a source code in XML format for each designed

template. The implemented templates are compiled in a special internal format and are stored in the Jaspersoft repository, which is realized in **Step 3**. By this manner they can be both used by the level of the very same UBIS-Jaspersoft system and by other external application for the generation of the relevant reports, that are filled with data from the given data source (Moodle database). The completed reports can be exported to a specified document format (PDF, XLS, XLSX, XML, HTML, XHTML, CSV, DOC, etc.).

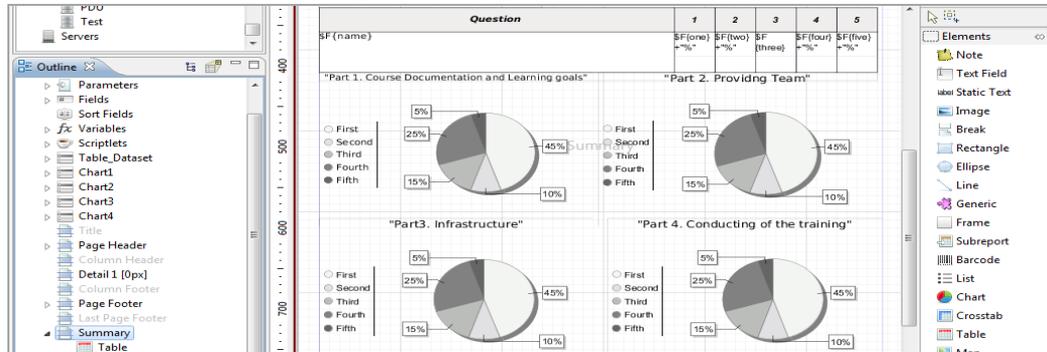


Figure 3. Template designing

Step 4. realizes the ultimate goal of the experiment to integrate LMS Moodle (as external application) with UBIS-Jaspersoft through the shared UBIS-Jaspersoft web services, represented in the integration service bus (fig. 1).

A new module is developed as a supplement to the LMS Moodle (as a Moodle report on a system level), which adds to the system the already implemented reporting functionality (Step1-3), using the corresponding web services. This allows the generation of reports based on the above-mentioned templates by the LMS level.

This reporting functionality can be used in a similar way to expand the functionality of other systems and for the development of higher level business services.

EXPERIMENT: CONFORMITY OF E-LEARNING QUALITY WITH STANDARDS

The purpose of the second experiment is to provide opportunities for LMS Moodle to provide data to other specialized tools for automation of internal or external evaluation procedures (other software systems or high level business services). That is why, the extracted data must allow conformity verification of training conducted in LMS Moodle with appropriate quality standards.

In accordance with the selected software architectural model, 4 (four) experimental web services are developed to support corresponding Moodle integration. The services and their functions are selected in such a way as to provide data (extracted from the Moodle database), applicable in evaluation of some of the most common indicators of the known e-learning quality standards. Table 1 describes web services, the results returned by the functions implemented by them (from conceptual viewpoint) and respectively in the evaluation of which quality indicator, they can be used.

Table 1. Web-services for evaluation of e-learning quality indicators

| Web Service | Web Service Functions Results | Quality Indicator |
|-------------|---|--|
| 1. | A list of team member names providing e-learning, the relevant e-courses and their role (administrator, teacher, tutor, evaluator, educational content designer, author, quality manager, etc.) in each of the courses | Team for provision of design, implementation and maintenance of e-learning |
| 2. | A list of various learning activities and resources used in the training (lesson, page, book, quiz, assignment, chat, choice, database, forum, glossary) and their number for each e-course | Provision of e-learning with virtual learning activities and resources |
| 3. | Teachers' and students' activity in usage of tools for synchronous communication for each e-course Teachers' and students' activity in usage of tools for asynchronous communication for each e-course Usage intensity of communication tools (synchronous and asynchronous) by teachers and students | System for control and stimulation of students' and teachers' activity |
| 4. | Participation duration in e-learning (real use of activities and resources) by the e-students (incl. in different courses) | Sustainability of the ensured e-learning infrastructure |

Web services are developed according to the documentation for the creation of web services in Moodle [3, 4]. It is envisaged the functions of each service to provide alternative access for client applications based on different protocols for client-server communication (XML-RPC, SOAP, REST) and also to support the exchange of data via the most popular for this purpose protocol (XML, JSON, AMF). The implemented web services were tested through specially developed client applications.

CONCLUSION

The study and experiments, exposed in the current paper prove the feasibility of the Service Oriented Integration approach for HE needs. It provides a common base for integration of the full range of heterogeneous university information systems (providing student admission, training, teaching, researches, management, educational marketing, quality control, etc.) in order to improve the management, performance, reliability and especially openness of a university to offer new services in response to specific needs.

The results described in the paper are achieved as part of a project for the implementation of the studied architectural model carried out at the Plovdiv University [1]. The final stage of realizing an overall modern solution for automated quality evaluation of e-learning is yet to take place. The building of the Integration Service Bus will be completed by presenting through web services the student administration system (which will provide data about students, curricula, etc.), academic staff development system (providing data for teacher competences) etc. Based on this, it will be possible for different processes related to assurance and evaluation of the quality of education to be automatized (presented on the Business Service Bus level).

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The paper has been reviewed.