FUNCTIONAL REQUIREMENTS ANALYSIS AND DESIGN OF J2EE COMPLIANT VIRTUAL CLASSROOM WEB APPLICATION

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ABSTRACT - This paper describes start-up of project which goal is to enable university teachers and students to use web-based e-learning system. Special care is taken on defining functional requirements concerning specific educational conditions in Serbian universities as on defining framework and design patterns for developing really parametric solution, in order to enable easy adding of new functions.

1. INTRODUCTION

Teaching online means conducting a course partially or entirely through the Internet. It's a form of distance education, a process that includes teaching courses through the mail, by video-tape, or via telephone hookups or satellite TV-any form of learning that doesn't involve the traditional classroom setting in which students and instructor must be at the same place at the same time.

Web may be a place to post information before class, in order to inspire a meaningful in-class discussion. The information on the Web may help students to get the proper context for a lecture, so that the lecture falls on well-informed ears.

A key limitation to learning is the over-emphasis on memorization of concepts and facts. Students can store information in their short-term memories, but must engage in practice and encoding techniques to permanently store information in long-term memory [2]. To promote learning, instructors must not simply post information online but also design strategies and tools that require students to actively process that information.

The goal of this project is to establish initial conditions for conducting teaching online at Faculty of Mechanical Engineering, University of Nis. The first phase of project realization, described in this paper assumes that road towards distance learning systems leads through transitional period in which traditional teaching methods shall be combined with e-learning tools.

2. RECOGNIZED PROBLEMS IN IMPLEMENTATION OF UNIVERSITY VIRTUAL CLASSROOM PORTAL

In university environment, especcially in countries with not well established e-culture and infrastructure, there are some issues that must be handled during the conceptualization and design of e-learning portal, in order to offer solutions for most common anticipated problems.

- Bad computer skills (from students as well as from teachers and teaching assistant) - Solution: Designing easy to use content management system, wizard-like procedures, strict validation of all user actions, pre-course training, descriptive help.
- Discouragement of student's participation - Solution: Applying methods for promoting participation, as described in paper. The instructor should not be the dispenser of knowledge, but rather, the facilitator of student-driven activity.
- Hard finding of specific information or knowledge (Learning material is most often submitted in format which can't be indexed on web server - PowerPoint presentation or Adobe Acrobat document) - Solution: Customizing learning environments by grouping knowledge in as many vertical and horizontal layers of abstraction as possible (courses, modules, topics)
- Slow outside network connections (Students are not enabled to find information on specific topic on Internet) - Solution: Establishing mirror sites or archives of on-line magazines, university departments, company institutes with valuable information and knowledge material.
- Discouragement of teacher participation (Course management system which would enable constrained functionality focused only to content will not be fun) - Solution: Enabling means for strong customization and achieving unique look of specific course channel - HTML templates, image libraries. Teacher must be encouraged to add "a personal touch" to virtual classrooms.

3. INITIAL KNOWLEDGE STRUCTURIZING STRATEGY

Educational content must be structurized with consideration of grouping teaching material into categories, disciplines, courses, modules and topics and time dimension in order to enable teachers to use portal functionality to create chronological course events and submissions. Also, structurization of submitted material in as many tree levels, as it is possible, help students to find material on specific topic easy, because it is hard to implement efficient search system.

3.1 Course content submissions

Initial knowledge cells can be all types of content (text, images, multimedia) and files that teacher found could be useful to students. The most common practices are to submit HTML files, PowerPoint presentations and Adobe Acrobat files.

It is recommended for all files to be submitted before lecturing to live audience. For every topic, announcement area must be designed, with space and tools for submitting latest updates and corrections. Some types of information that could appear in announcement area could be info on upcoming due dates of course (trial tests, exams) and stages as their updates and changes, offering preview or overview of current or upcoming activities, submitting comments on students weekly activity statistics and reminding students on live or special events (invited lecturers, workshops).

Also, for every module or topic, teacher must be enabled to submit links to knowledge specific web sites with always-opened call for student's evaluation and comments.

4. PROMOTING STUDENTS PARTICIPATION

One general way for promoting participation is to make online participation required and graded.

Basic way of participation is indication of logged on student. Measuring attendance can be achieved through tracking time of presence on each portal page or number of pages opened. For this purpose, various statistical analysis tools must be taken into consideration, depending on survey on actual teacher needs for defining attendance evaluation criterias.

Key is to achieve as much interaction in online course as it is possible, by finding a way to encourage students to participate, not only in discussions to teachers and teaching assistant but to each other.

In order to establish teamwork and lessen teacher workload in classes with lot of students, good practice could be to call for gathering students in small groups with representatives who could raise general problems and discussions in message boards. By that way, teacher can identify major flaws in class program and get directions for class improvement. Also, this could prevent for answering on one questions many times.

Another way to encourage student's participation could be active teacher involvement in message boards and starting threads by him(her)self. Also, forum threads should be organized in that way to reflect the class chronology or sequence.

By sending students on virtual "field trips" after submitting them interesting links on specific topic, teacher can encourage participation by asking for comments on submitted material. Also, by that way, teacher could expect from students to submit latest updates on topic and discuss them online.

Motivation and interest can be supported by designing authentic projects or tasks that the teacher can see are relevant to their future needs (e.g., online cases, problems, simulated situations).

5. BRINGING COLLABORATIVE E-LEARNING IN PRACTICE

The strength of e-learning is in bringing real collaborative knowledge exchange by mixing well-known andragogy methods and e-learn practices into web environment. Main web tools for achieving goal of well-motivated and efficient learning are discussion boards, with shared on-line communities paradigm in mind, live chats and groupware applications.

5.1 Discussion boards

A discussion board is an asynchronous communication tool that allows one individual to post a comment or question online. Other individuals who are members of the same discussion board may read that comment/question, and respond with their own remarks over time.

Usage of discussion boards in on-line learning system extends time needed for discussions beyond regular class time and, by that, allow for in-depth analysis and consideration of submitted comments.

Discussion board can be, also, the field for first evaluation of student's knowledge and learned skills. This is especially applicable in topics and fields where quality of submitted answers can't be evaluated simply by using binary grades (true, false), but also can be the matter of discussion.In teacher's moderated message board discussion, two factors must be measured: activity and responsiveness. Student can read submitted assignment or respond to it. Submitted responses can be read, evaluated and graded.

Good submissions (or whole threads) can be spotlighted by marked as useful and displayed in front areas of message boards.

Thread topics must enable functionality of keying (relating) to course documents, assignments, project or exercises to which learning material they reference.

5.2 Shared communities

Beyond simple message board to which write access is limited only to students in attendance and teachers and teachers assistants, for every course, open online community channel can be designed, in order to aggregate various knowledge elements from people all over the world.

Students can meet other students from around the world studying the same subjects in our discipline-specific communities.

Instructors could share tips and best practices with each other in both discipline-specific communities and communities that address general online teaching issues.

5.3 Educational Live Chats

Electronic chats are a synchronous form of communication, closely resembling actual, real-time conversations.

Chats can be general or scheduled - moderated by teacher. Chats moderators must be enabled with functionality to address to other chat participants with uploaded image which could reflect his (her) remarks clearer. Moderated live chats should be archived for closer analysis at later date.

Beyond that live chats can be used to carry out formal or informal discussions about current events, ongoing projects, and many other issues, they are necessary means for groupware in geographically dispersed student communities. Also, they are means for fast teacher responses in scheduled mentoring sessions. Mentoring is way for students to communicate with experts in a field, in order to ask questions or to receive feedback on their work.

However, special care must be taken to design the chat system so it can easy support effective synchronous communication of as many users as it can, because bigger live chat group communication could be confusing for students or could likely slow the server or even crash it.

5.4 Group projects

Discussion boards and chats are, also, powerful tools for enabling groupware in university environments. One very important issue that should be kept in mind is that discussion boards and chats must be defined as private here, in order to isolate spam and focus the discussion on specific project matters.

Establishing a virtual drive - storage area for sharing files with read only, read/write or read/write/delete roles for every team member, issued by team leader - can be, also, very good practice. By having this functionality, system will enable project members - full coverage of current project, also in geographically dispersed environments.

Using the electronic virtual drive, students can post their papers or other electronic documents online. One or more team members can review the document and post feedback online using the private discussion board.

To promote groupware, tasks and assignments must be assembled into projects with usable and practical results. For each group project, external industry or knowledge-specific collaboration could be required to raise the results usability. Also, web centric system would enable participation of students from other universities.

6. METHODS FOR EVALUATION OF STUDENTS ACTIVITY AND GRADING OF COMPLETED ASSIGNMENTS

Very important is to establish criteria for measuring quantity and quality of participation. Whatever quantity/quality ratio you choose, team work in shared classrooms or message boards and team project presentations should be graded more than individual skills and knowledge, showed in completed assignments submitted to teacher.

Three of the most important issues that should be taken into consideration before actual design of virtual classroom portal are on-line exams, on-line quizzes and gradebooks.

On-line exams system must enable pre-exam evaluation and self-preparation with previously posted or issues tests as trial or real on-line exam with functionality for issuing grade and comment.

Gradebook is means for keeping track of student responses on submitted assignments and scheduled tests and each student grades.

6.1 On-line quizzes

Online quizzes are very important e-learning feature that could enable student's self-evaluation of knowledge and best reflect the student readyness for tests or final exams. Students can monitor their course progress and seek help or revise study on poorly comprehended subjects.

Also, quizzes can be useful tool for teachers which they can use to evaluate general course progress and identify topics which are not presented well and schedule additional classes, moderated chats on that subject, start a new thread on topic in discussion boards, or submit updated learning material.

Typical item types available for online quizzes include: multiple choices, multiple answer, true/false, fill-in-the-blank, matching, ordering, and short answer. All item types can be automatically scored except for short answer items. The auto-score is entered into an electronic gradebook or spreadsheet and taken into consideration for final score.

Online quizzes can be built from large pools of items, thus different quizzes can be rapidly and even randomly generated for students who missed a scheduled exam period, for different course sections, or for new sections during subsequent semesters.

Online quizzes allow the instructor to construct questions where a web page, image or any file from submitted teaching material is referenced.

7. FRAMEWORK AND DESIGN PATTERNS FOR DEVELOPING OF UNIVERSITY VIRTUAL CLASSROOM PORTAL

It is anticipated that Virtual Classroom portal would face many workload challenges during exploitation, due to great number of potential users. For this reason, it is necessary to choose robust platform which would enable easy administration, error checking and application monitoring.

In order to enable simple portal upgrades, there is a need for directing web site development and its run-time characteristics through a design process that encourages effective analysis and documentation. This will result in modularity and parametricity quality features in a best possible way.
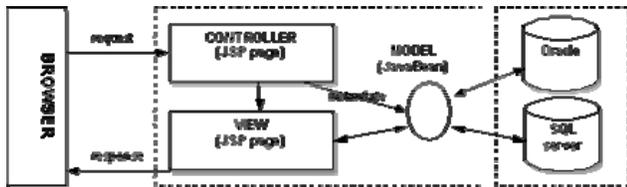
Figure 1. "MVC Model II" diagram

Based on previous experiences with three-tiered applications, designed at Faculty of Mechanical Engineering at Nis, it is decided that J2EE environment will be used as established industrial standard for web applications, with extensive use of UML in conceptualization and design phase. As a design pattern, Sun's recommended MVC Model 2 will be combined with elements of Web Director framework [4].

The Model 2 architecture, shown in Figure 1, is a hybrid approach for serving dynamic content, since it combines the use of both servlets and JSP. It takes advantage of the predominant strengths of both technologies, using JSP to generate the presentation layer and servlets to perform process-intensive tasks. Here, the servlet acts as the controller and is in charge of the request processing and the creation of any beans or objects used by the JSP, as well as deciding, depending on the user's actions, which JSP page to forward the request to. Note particularly that there is no processing logic within the JSP page itself; it is simply responsible for retrieving any objects or beans that may have been previously created by the servlet, and extracting the dynamic content from that servlet for insertion within static templates.

First step in design of e-learning portal should be to describe web application functionality, by using UML classes for each page and use-cases state diagrams to describe web scenario. The most important class in design is Action.jsp page which serves as a controller in MVC design pattern and which processes all requests and dispatches data to appropriate View pages, by putting it into session. One example of usage of Action.jsp page is shown at Figure 2.
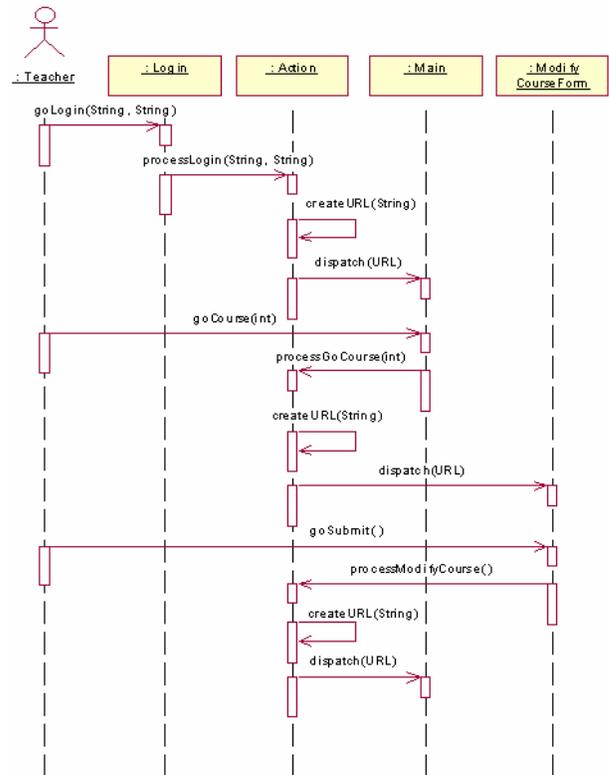
Figure 2. Sequential diagram for Manipulating Courses use-case, which demonstrates MVC Model Design Pattern

Displayed sequential diagram can document all interactions between classes and actors, necessary to complete action of modifying data about submitted course.

As recommended by Web Director framework specification, in first phase of design, series of UML state diagrams will be designed, for each use-case. Each of state diagrams reflects one storyboard for web scenario, as it is shown for the use-case of manipulating courses for teachers (Figure 3). As it can be seen on Figure 3, Action.jsp appearance in state diagrams is neglected, because of clearer understanding of message paths.

Figure 3. Storyboard UML state diagram for Manipulating Courses use-case

State transitions which reflect changes of browser Window class are shown at Figure 3. Paradigm of UML class events is represented by user page actions (link or button clicks). Events are processed with arguments that assembles query string for next scene. Actions are event handlers, usually defined in <head> section of HTML Document with JavaScript functions.

For modeling of data layer, E/R diagram (Figure 4) is made by using UML (Rational Rose), with defined database table structure, primary and foreign keys and indexes. For generating actual Oracle database instance, Rational Rose generated SQL script is used.

Figure 4. E/R diagram used for generating Oracle database instance

As it can be noticed from E/R diagram, in the first version of Virtual Classroom web application, due to the server power limitations and well-established teaching methods at most of Serbian universities, live chat, gradebooks and groupware systems are not included in system requirements, and they will be added gradually, during e-learning portal life.

8. CONCLUSION

At this moment, it is noticed that there are three main factors that may slow down process of involving web-based e-learning systems in Serbian university environments:

- Lack of e-mentality, combined with low level of general computer skills,
- Slow network infrastructure and
- Rigidity of Serbian educational system and possible personal reactions on proposed need for integrating web-based e-learning methods and principles into general education program.

Intended goal of this project is not to enforce teachers and students to use Virtual Classroom portal, but to assure them that it is necessary, through informally recommended use in trial period. That is the reason why author included only limited set of functionality with emphasis on it's quality and applicability in our, specific environment. Once, critical mass of users (teachers and students) start with using portal and network infrastructure is raised on level needed for bandwidth consuming applications, additional functionality will be added in "step by step" manner.

By using J2EE technologies and design patterns depicted in paper, it will be very easy for additional functionality to be added later.

9. REFERENCES

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