Web-based e-learning environment

Milan Mišovič

Abstract — Using a progressive information technologies for development of web-based courses and their administration brings a lot of practical and theoretical problems. We know web course problem is only small solution concerning construction of a large entire web-based e-learning environment. One of a practical problem is how to construct web-based electronic courses that have to meet international AICC standards. Implementation of such strict statements resulted in a lot of small or larger difficulties if we had used an elementary HTML editor. Using a special web course oriented editors can absolutely solve this problem. The second problem is construction of the web-based e-learning application that can administrate such web courses and takes into consideration AICC regulations. Development of such web applications is founded on the latest web technologies. This article introduces one approach to the modeling of the two most important components (web-based course, web-based application) of the web-based e-learning environment, convenient for Military Academy in Brno and Czech army. The article outlines the structure of web subject, e-learning environment and their implementation1. The LMS’s structure and its functionality, based on a snaps algebra, belong to important results of the article.

1. Introduction

According to the American Council on Education (Guiding Principles for Distance Education in a Learning Society, 1996) we can take over its definition of distant learning as: “Distance learning is a system and a process that connects all participants and resources (learners with distributed learning resources, educators with learners, learners with learners)”. The term “distance learning” is very often interchanged by the second term “distance education”. There are two categories of distance education delivery systems: synchronous and asynchronous. The first system requires the simultaneous participation of all students and instructors, by another words – interaction is done in “real time”. There are known such implementations as: interactive TV, tele- and video-conferencing, web-conferencing, synchronous chat, virtual whiteboard etc.

1Some results from a complex solution for the project of web-based learning environment.
Development of web-based e-learning courses is founded on web technologies HTML and DHTML. There are very often used special course editors. These editors can usually solve problem of web course distribution, too. Pedagogical approach and web course administration are enabled by a special web-based e-learning application (learning management system – LMS). Modeling of such applications has to follow a lot of important rules.

2. Web course’s structure

Generally, any web course can be constructed as a set of several web subjects. Even though, the common case is only one web subject. The content of any web course can consist of the following parts (Fig. 1):

- home page, welcome page and introducing pages for all web subjects;
- web subjects, which are expressed very often by HTML or DHTML pages;
- the data base “web course properties”; this data base points to information linkages among the components of web subjects.

Figure 2 outlines possible web subject structures. This structure corresponds to the current subject in Military College Education.

3. Web-based learning environment structure

In order to model the e-learning problem domain we have to recognize all its structure, properties etc. Finding out of
a good structure is the main problem. Next structure can be acceptable:

- web course subjects;
- clients of web course;
- education supervising;
- communication;
- data bases: “web course properties”, “operational DB”, “reserved DB”;
- administration of web course – learning management system.

This structure enables connectivity clients – web subjects – data base only by means of the LMS (Fig. 3). This idea can influence the data model and web subject protection (code on a server farm).

The LMS will certainly appear as a web-based application with more than three layers (client code, server code, distributed data and distributed code).

Figure 4 outlines elementary implementation of the LMS on teacher’s computer and on military academy’s server.

4. The main e-learning’s functions

The analysis of web-based e-learning environment subjects has shown that the list of the main functions should contain at least the following functions:

1. To enable client access to the web subjects according to client access permission.
2. To provide a guest show for some clients.
3. To make up possibility for a full text searching in the content of web subjects.
4. To register students activities in web subjects (monitoring).
5. To enable all teachers to get information about any student activities.
6. To give study possibilities for young teachers.
7. To organize all types of communication.
8. To provide comfort for modification of web subject content.
9. To make up a flexible communication with data base server.
10. To protect all information which has fatal meaning for LMS.
11. To record all activities in web-based e-learning environment.

5. Learning management system

The learning management system (Fig. 5) is web-based e-learning application for web course administration. Its structure corresponds to the web-based e-learning environment (Fig. 6). Generally, it should play several important roles, for example:

- administration and communication roles;
- pedagogical role;
- service role.

Special managers or assistants perform each role in the LMS. The LMS core reacts on all internal events.

6. Philosophic fundament of the LMS’s work

Philosophy of the LMS’ work is founded on producing and processing of snaps. The snap instances are the main products of the LMS. Snaps are produced in all reactions on events and their usage has a lot of possibilities for processing. Each instance of a snap is addressed by web course session-ID, web course subject-ID, client-ID, time and own snap-ID. Therefore, compatibility will be the basic property of snaps.

Creation of the snap is almost performed according to Fig. 8. Internal meaning of a snap is given by its using in the LMS. All types of snaps are named in Fig. 9. The LMS application generally accepts seven of client types:

- administrator,
- guarantee of web course,
- guarantee of web subject,
- instructor,
- student,
- external client and guest.

Valid access permission rights are defined in advance. The content of each access permission right consists of operations, those can be started by client from his interface. By the way, snaps can be used for evaluation of learning progress quality, web subjects, pedagogical activities of instructors and convenience of the LMS.

This large using of snaps converts the LMS system to the learning quality management system (LQMS).

**Definition 1.** Entity “snap” is regarded as notation \((C, W_c, W_s, W_t, T, t)\), where \(C, W_c, W_s, W_t, T; \) and \(t\) are sets of clients, web courses, web subjects, web tests, transactions and time \(t_0 : t_f\) for e-learning environment session. The value of \(T\) determines a snap type.

The following text describes a special snap algebra which gives basic theoretical and practical approach to the snaps.

Operations in this algebra provide sufficient evaluation possibilities for all types of web course administrations. These operations are defined with respect to compatibility of snaps. Therefore, compatibility will be the basic property of snaps.

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**Fig. 5.** The LMS’s structure.
Fig. 6. Implementation of e-learning’s functions in the LMS.

Fig. 7. Using of AICC regulations.

Fig. 8. Creating of snaps.
7. The snap algebra

Set of elements ..........Instances of snaps x, y, z, ...
Special element ..........Empty snap E.

Definition 2. Snaps x, y are λ-compatible, if the sets
\{C^x, W^x, W^y, T^x, t^x\},
\{C^y, W^y, W^x, T^y, t^y\} have not empty disjunction.
λ-compatibility represents a certain number of equalities
from the set
\{C^x=C^y, W^x=W^y, W^y=W^x, T^x=T^y, T^y=T^x, t^x=t^y\}.

Interpretation λ-compatibility by one equality leads to compat-
ibility of the first level:

Client ........................................ x ∼ y ⇔ λ : C^x = C^y

Web course ......................... x ∉ y ⇔ λ : W^x = W^y

Web subject ...................... x ⊕ y ⇔ λ : W^x = W^y

Transaction ...................... x ⊕ y ⇔ λ : T^x = T^y

λ-compatibilities of the second or higher level provide very
useful sets of e-learning environment snaps. For example:

Client-subject  λ : C^x = C^y, W^x = W^y
compatibility generates all snaps of given client with the same web sub-
ject.

Subject-test  λ : W^x = W^y, W^y = W^x
compatibility generates all snaps of given web subject and web test in it.

Basic operation.............. t-concatenation for t_x < t_y of
the both snaps x, y with the same λ-compatibility.
Notation........ x ⊕ y (x ⊕ x is not defined).
Operation is not symmetrical but there is valid
E ⊕ x = x ⊕ E = x and x ⊕ (y ⊕ z) = (x ⊕ y) ⊕ z.

Concatenation x ⊕ y ⊕ z of the snaps x, y, z with
λ-compatibility, represents a string of the same compat-
ibility. For graphical presentation such strings we can use following chart:

Another general operations........ x < y, x > y.
(time relations)
Operation x = y is not defined and x ≠ y is trivial.

Axioms........There are not the same snaps for given client.
Session with the e-learning environment is the highest snap.
There are four very important strings within learning progress administration:

1. Session with e-learning environment.
2. Session with web course.
3. Session with web subject.
4. Session with web subject test.

Each of these strings starts with “Start snap with...” and ends with “End snap of...”. We can construct these strings by next operations. The snaps expressing the moving (clicking on hyperlinks) within a web subject have huge importance, too.

We can defined a specific number of convenient operations for each set of λ-compatible snaps, naturally with respect to requirements of administration types.

For example, we can suggest a list of such operations in the client-compatibility with respect to needs of learning progress administration:

E-learning environment session......List of all e-learning environment sessions
Web course sessions.................List of all web course sessions
Web course session...................List of sessions
Web subject sessions..................List of all sessions
Web subject session..................List of all sessions

Hyperlink web subject session.......String of used hyperlinks in subject
Hyperlink course session.............String of used hyperlinks in course
Question moving string.............String of movements in web test
Question answer string.............String of answers in web test

By the same manner we can design a lot of useful operations in another very important sets of λ-compatible web snaps. For example, we can observe web subject using the loading of selected LMS transaction, pedagogical instructor activities etc. Naturally, if we find out that our list of snap types is not sufficient for the purposes of administration types, we can introduce another snap types. By this manner we can enlarge the LMS application.

8. Manager operations

The manager operations are derived from the main system functions of e-learning environment. The number of such operations can be larger then one hundred. Clients can start these operations from theirs interfaces only in accordance with access permission rights. These rights are different for each client type.

For example we introduce only several important manager operations:

<table>
<thead>
<tr>
<th>ACCESS MANAGER</th>
<th>Guest show start</th>
<th>Login modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign in/Sign out</td>
<td>Guest show end</td>
<td>Login modification</td>
</tr>
<tr>
<td>Registration</td>
<td>Login</td>
<td>Login creation</td>
</tr>
<tr>
<td>Login prologation</td>
<td>Personal data modification</td>
<td>Login cancellation</td>
</tr>
<tr>
<td>Verification of access frequency</td>
<td>Login processing</td>
<td>Access permission right delegation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MESSAGE MANAGER</th>
<th>Message restriction views</th>
<th>Message canceling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message creation</td>
<td>Message archiving</td>
<td>Message canceling</td>
</tr>
<tr>
<td>Message sending</td>
<td>Message symptom settings</td>
<td>Client calendar</td>
</tr>
<tr>
<td>View of messages</td>
<td>Message folder creation/canceling</td>
<td>Class table operations</td>
</tr>
<tr>
<td>Message view</td>
<td>Discussion table operations</td>
<td>Message manager settings</td>
</tr>
</tbody>
</table>

9. Conclusion

There are a lot of problems that belong to the range of web-based e-learning environment. This article has pointed only to the selected set of structural problems during its modeling. One complete modeling solution has been given in the research report “Problem Domain of eLearning” that was reviewed and accepted in January 23, 2002 (see [3]).

References


Milan Mišovič an Associate Professor, senior lecturer, Doctor of Natural Sciences, Ph.D. of the Military Academy in Brno, Czech Republic; Head of IS Programming Tools Group. His area of scientific interest comprises: theoretical informatics, theoretical and practical aspects of software engineering and information engineering, IS methodologies, integrated development environments, development of web applications.
e-mail: milan.misovic@vabo.cz
Department of Automated Command Systems and Informatics
Military Academy Brno
612 00 Brno, Czech Republic