Paper

Web-based e-learning environment

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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 implementation[1]. The LMS's structure and its functionality, based on a snaps algebra, belong to important results of the article.

Keywords — distance learning, e-learning, web-based course, web-based e-learning environment, web distributed application, learning management system, web course subjects, clients, access permission rights, communication, administration of web-based courses, e-learning functions, client interface, LMS manager, manager operations, activity snaps, algebra of snaps.

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.

[1]Some results from a complex solution for the project of web-based learning environment.

On the other hand, the second system does not require the simultaneous participation of all students and instructors. Students do not need to be gathered together in the same place at the same time. They can select their education time and learning resources that are needed. This system of education is more flexible then the former. There are known such implementations as: correspondence courses, videotaped courses, e-mail and web-based courses, etc.
The present and future possibility of distance learning is very tightly connected with the development of electronic telecomputing technology, especially with development of Internet/Intranet and multimedia technology. Modern web-based electronic learning environment can significantly integrate such tools for presentation as voice, video, and data connections between and among instructors, learners, subject matters experts, virtual libraries and Internet resources. Modern web-based e-learning consists of several mutually dependent parts, included in its strategy:

– development of web course content (subject matters);

– pedagogical approach;

– web course administration;

– web course distribution.

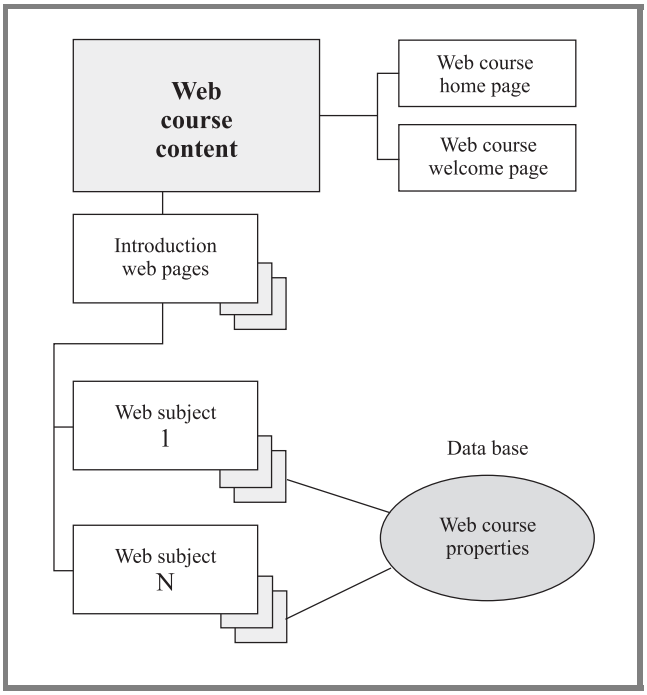


Fig. 1. Web course content structure.

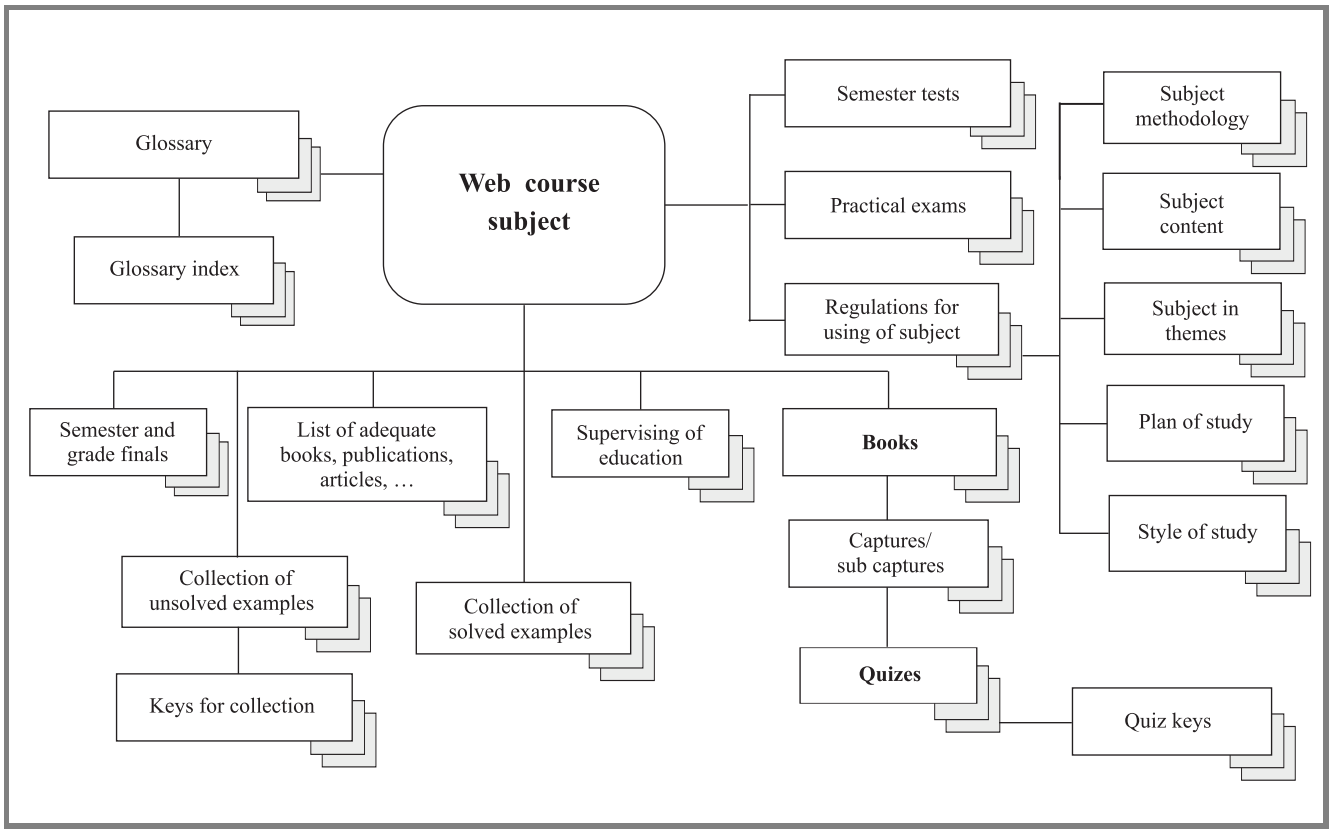


Fig. 2. Web course subject structure.

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 manegement 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

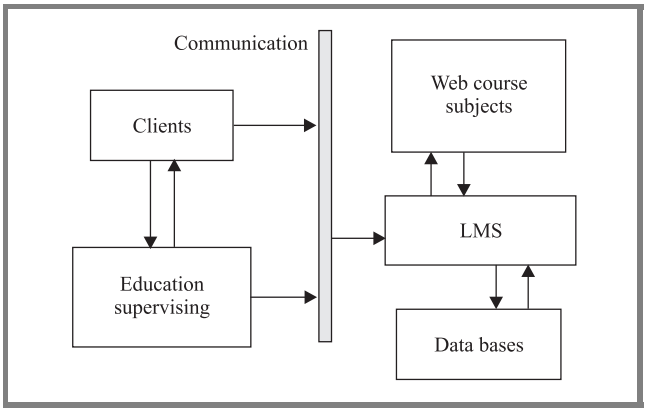


Fig. 3. Structure of web-based learning environment in subjects.

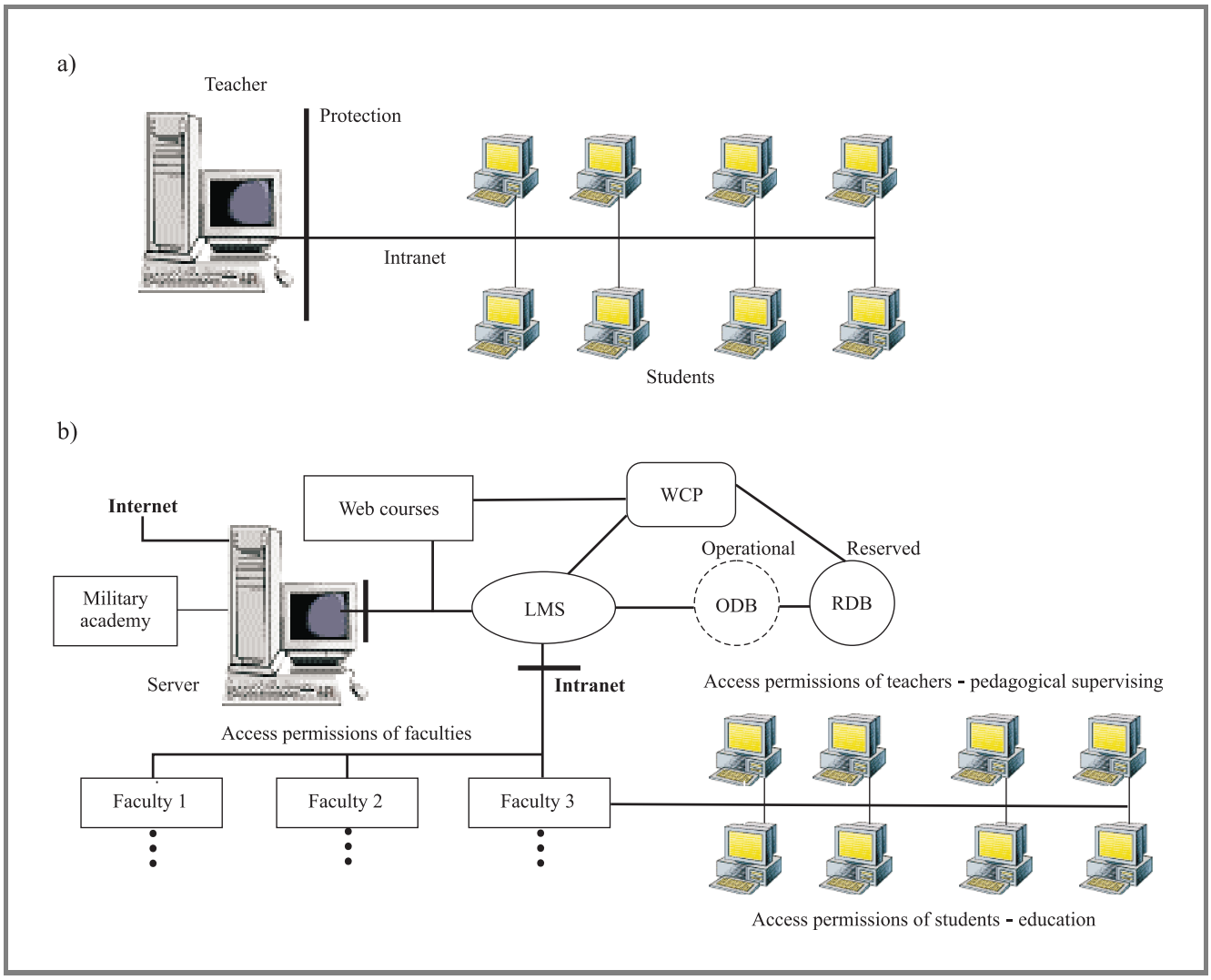


Fig. 4. Technical and software equipment of the Intranet and Internet web-based learning environment: (a) teacher's computer: Win98/Win2000, personal web server or Internet information server, learning management system, web course subjects; (b) military academy's server.

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 then 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.

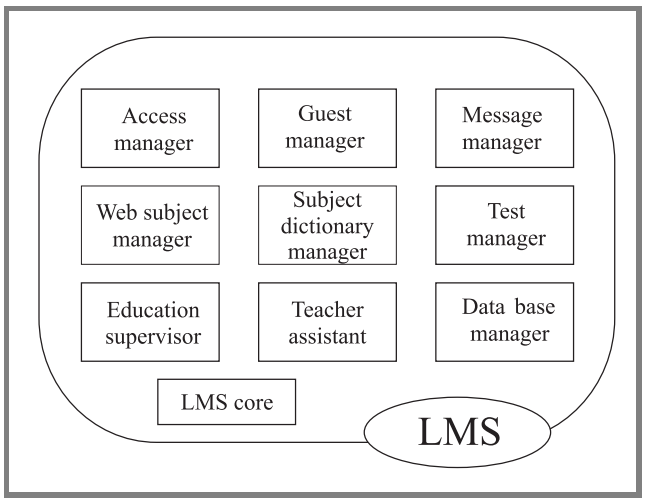


Fig. 5. The LMS's structure.

All makers of web courses have to follow AICC regulations (Fig. 7). It can be fulfilled by selection one of modern web course editors.
Interaction between the constructed web course and the LMS is performed by means of special "interaction doors".

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 client, web course session, web course subject, web subject test, transaction and time can describe each snap instance.
There are two types of snaps. The first snap is called registration snap. It contains only a name of performed transaction in its properties. In addition the previous possibilities, the second "full" snap contains also input and output parameters of executed transaction.
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 $t_0 : t_1$ 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.

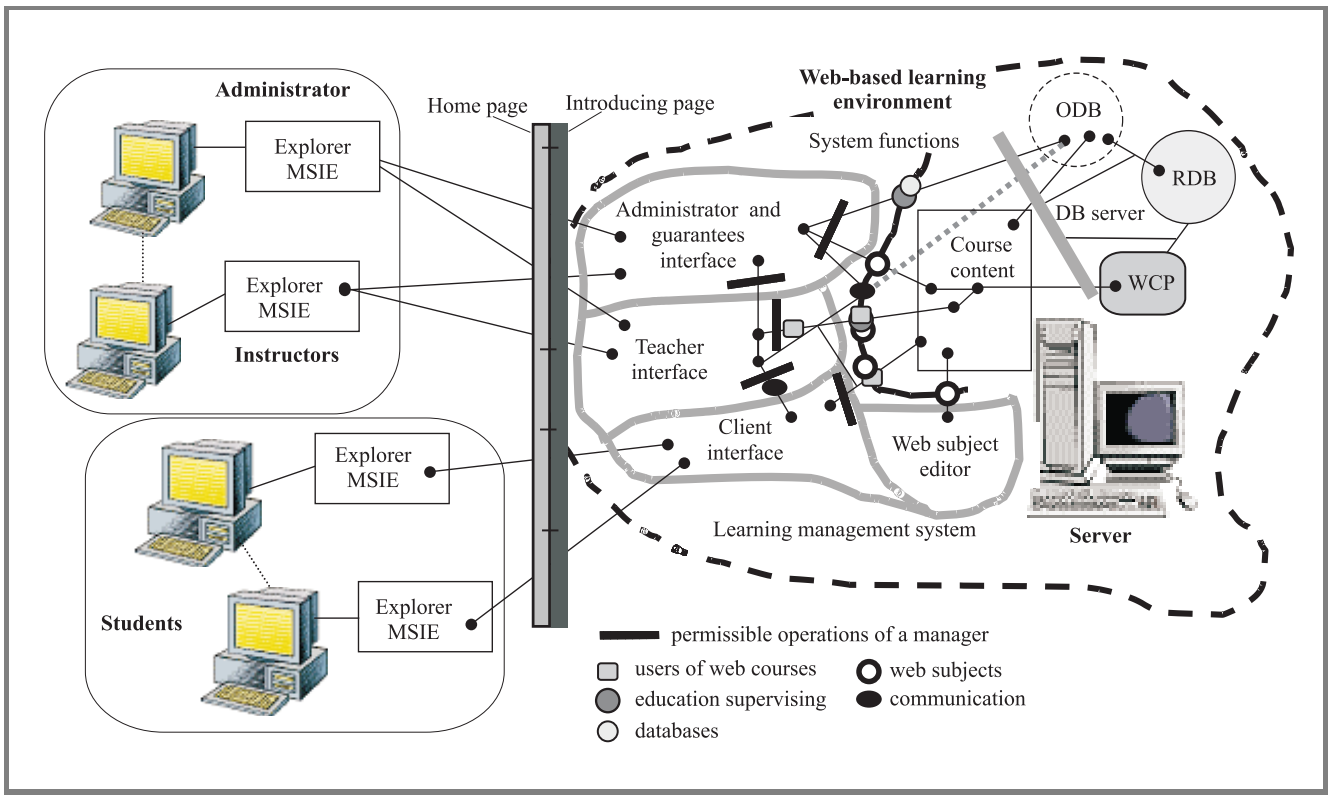


Fig. 6. Implementation of e-learning's functions in the LMS.

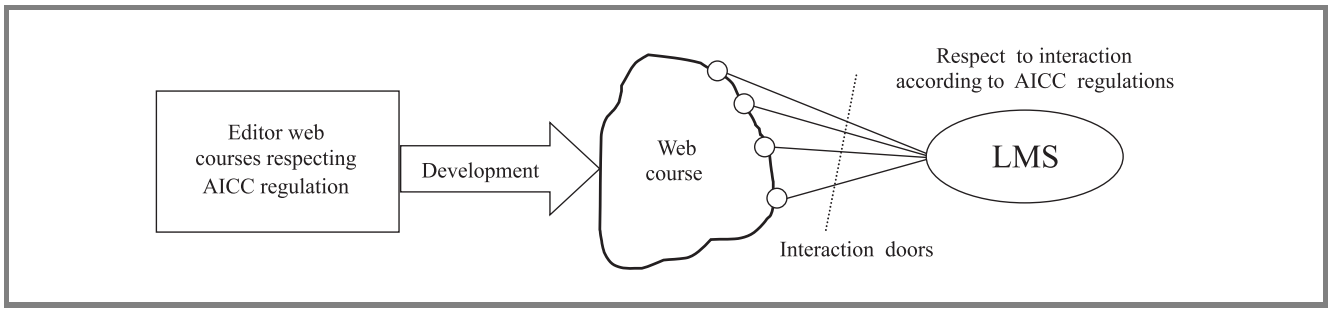


Fig. 7. Using of AICC regulations.

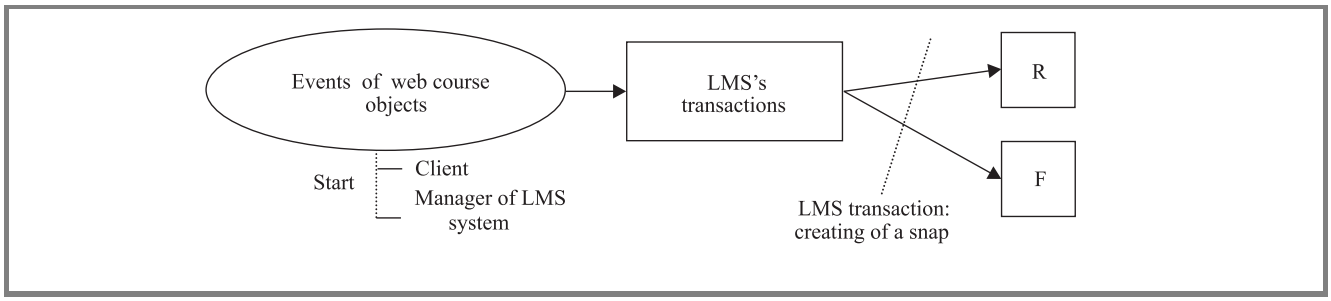


Fig. 8. Creating of snaps.

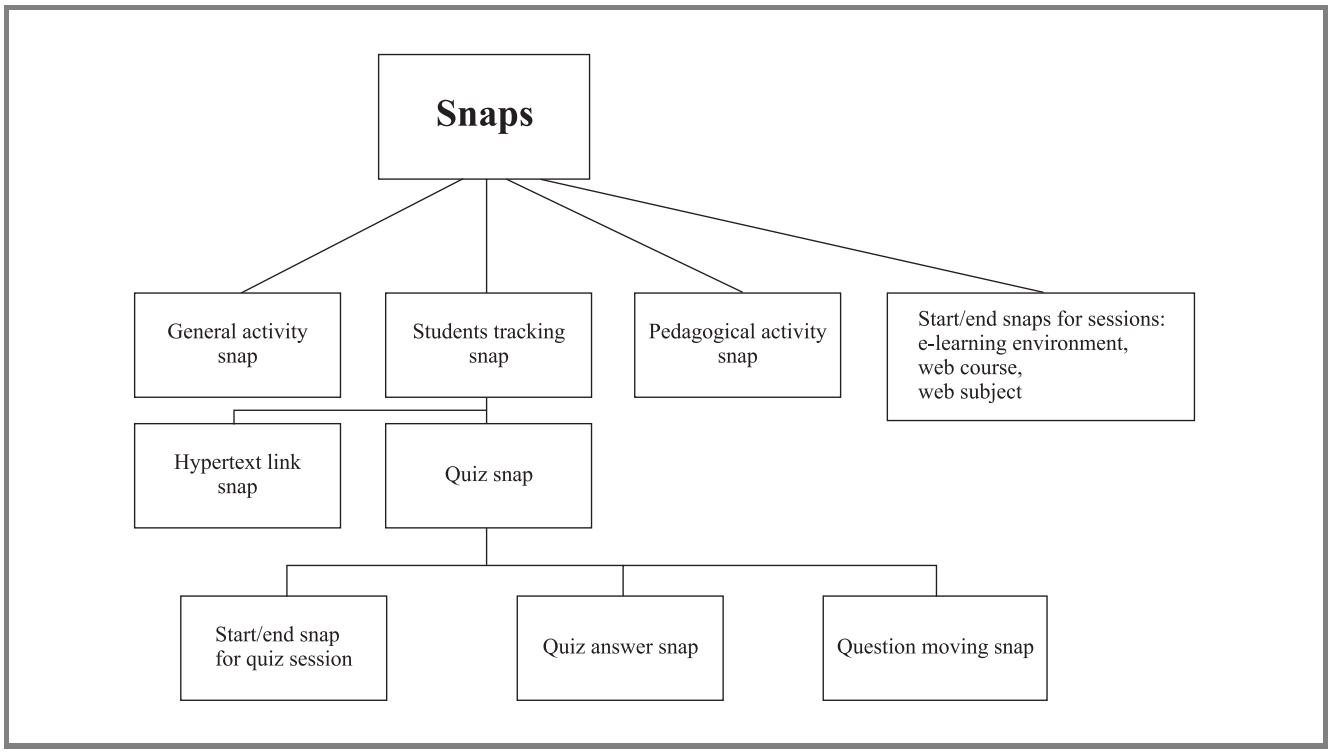


Fig. 9. Structure of web environment snaps.

7. The snap algebra

Set of elements .....Instances of snaps $\boldsymbol{x, y, z,}$...
Special element .....Empty snap $\boldsymbol{\varepsilon}$.

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

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

Client ..... $x \approx y \iff \lambda : C^x = C^y$
compatibility

Web course ..... $x \equiv y \iff \lambda : W_c^x = W_c^y$
compatibility

Web subject ..... $x \div y \iff \lambda : W_s^x = W_s^y$
compatibility

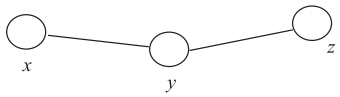
Transaction..... $x \div y \iff \lambda : T^x = T^y$
compatibility

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

Client-subject $\lambda : C^x = C^y,\ \ W_s^x = W_s^y$
compatibility
generates all snaps of given client with the same web subject.
Subject-test $\lambda : W_s^x = W_s^y,\ W_t^x = W_t^y$
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..... $\boldsymbol{x \oplus y}$ ($y \oplus x$ is not defined).
Operation is not symmetrical but there is valid
$\boldsymbol{\varepsilon} \oplus x = x \oplus \boldsymbol{\varepsilon} = x$ and $x \oplus (y \oplus z) = (x \oplus y) \oplus z$.

Concatenation $\boldsymbol{x \oplus y \oplus z}$ of the snaps x, y, z with λ-compatibility, represents a string of the same compatibility. For graphical presentation such strings we can use following chart:



Another general operations..... $\boldsymbol{x < y},\ \ \boldsymbol{x > y}$,
(time relations)
Operation $\boldsymbol{x = y}$ is not defined and $\boldsymbol{x \neq y}$ 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
EES (C) environment sessions

Web course sessions.....List of all web course
WCSS $(C, t_0 : t_1)$ sessions

Web course session.....List of sessions
WCS $(C, W_c, t_0 : t_1)$ with given web course

Web subject sessions.....List of sessions
WSSS $(C, W_c, t_0 : t_1)$ with all subjects

Web subject session.....List of all sessions
WSS $(C, W_c, W_s, t_0 : t_1)$ with the same subject

Hyperlink web subject session.....String of used
HWSS $(C, W_c, W_s, t_0 : t_1)$ hyperlinks in subject

Hyperlink course session.....String of used
HCS $(C, W_c, W_s, t_0 : t_1)$ hyperlinks in course

Question moving string.....String of movements
QMS $(C, W_c, W_s, W_t, t_0 : t_1)$ in web test

Question answer string.....String of answers
QAS $(C, W_c, W_s, W_t, t_0 : t_1)$ 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:

ACCESS MANAGER	Guest show start	Login modification
Sign in/Sign out	Guest show end	Login creation
Registration	Login expiration	Login cancel
Login prologation	Personal data modification	Login prolongation prompt
Verification of access frequency	Login processing	Access permission right delegation
Access manager settings		
.....		

Message creation	Message archiving	Message canceling

MESSAGE MANAGER	Message restriction views	Message blocking
Message sending	Message symptom settings	Client calendar
View of messages	Message folder creation/canceling	Class table operations
Message view	Discussion table operations	Message manager settings
.....		

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

[1] J. Rosemberg, *e-Learning Strategies for Delivering Knowledge in the Digital Age*. New York: McGraw-Hill, 2001.

[2] M. Mišovič, Case study, project "Support of distance learning". Military Academy Brno, Czech Republic, 2001.

[3] M. Mišovič, Research report, "Problem Domain of eLearning", Military Academy Brno, Czech Republic, 2002.

[4] M. Mišovič, "Basics for Development of Web Courses", NATINEADS, Brno, Czech Republic, 2002.

[5] M. Mišovič, "eLearning in Military Professional Education", BELCOM, Prague, Czech Republic, 2002.

[6] L. Petras, "Contemporary state and future of military personal education", Case study, Military Academy Brno, Czech Republic, 2001.

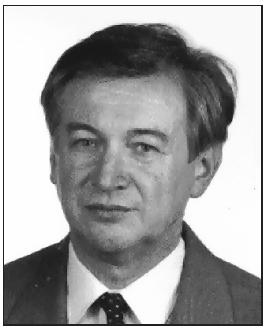
[7] J. R. Ballard and R. D. Kirkwood, "Interactive education for 21st century – the armed forces staff college and education of future decision-makers", I/ITSEC, Orlando, USA, 2001.

[8] J. Camacho, "The impact of advanced distributed learning (ADL) on joint readiness – an operational view", I/ITSEC, Orlando, USA, 2001.

[9] M. Myjak *et al.*, "The quest towards an advanced learning management system", I/ITSEC, Orlando, USA, 2001.

[10] F. Ionescu *et al.*, "Collaborative distributed learning environment for continuing education", ITEC, Lille, 2002.

[11] F. Gardiner, "Training quality system – where QMS meets LMS", ITEC, Lille, 2002.



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