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MODELLING VIRTUAL LEARNING ENVIRONMENT

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Abstract. The paper deals with the analysis of the structure, functions and design of virtual learning environments. By generalizing results of the analysis, the Lithuanian Virtual Learning Environment (LVLE) has been modelled and an analysis of its possibilities presented. LVLE is functioning; the areas of expansion have been established to ensure its development (with regard to educational paradigms, variety of learning styles, etc.). LVLE communicates with the user in Lithuanian.

Keywords: distance learning**,** virtual learning environment.

1. Indroduction

Information and communication technologies help to create a new learning environment characterised by the variety of information sources and communication. That is why specialists of educational change view information technologies as tools for accelerating and modernising educational process.

Such information technology can be modern virtual learning environments (VLE), having a convenient graphic user's interface and powerful tools for modelling a real learning environment.

Intensive research is being carried out in the sphere of the analysis and design of the structure and functions of VLE. This is testified by publications. Miller and Rice [14] in 1967 described the theory of the systems of organisation, which laid the foundations for planning the structure of some distance learning systems. In 1981, Kaye and Rumble [7] on the basis of this theory created a system of organising distance learning, which was developed and described in detail by Keegan [8]. In [1], the model of the teaching process is analysed and the main functions of the following VLE are described: WebCt, TopClass, CourseInfo, ToolBook II, Ceilidh, Plain WWW. In [19], a multi-agent distance learning system is investigated and compared with the conventional client-server architecture. In [16], LearningSpace, and CDK virtual learning environments are analysed. In [12], an active learning environment FLE3 is analysed. In [9], the structure of the LearningSpace Forum system is analysed in detail. Further intensive research is necessary first of all because of the constant development of the VLE and the appearance of the new ones. The second reason is a necessity to create the most flexible distance learning conditions and opportunities for people. For this, it is necessary to have a VLE, which would communicate with the user in his or her native language. This is particularly important for secondary school and for mature adult learners.

The aim of the paper is to carry out a structural and functional analysis of the VLE, having generalised the results of the analysis, to model the Lithuanian Virtual Learning Environment (LVLE) and to present the analysis of its possibilities.

2. The Overall Structure of the Virtual Learning Environment

An exhaustive analysis of the possibilities of VLE has highlighted detail properties of various environments. In order to make the assimilation of the VLE easier, structural parts of the frequently used environments and a standard prototype of a VLE are presented [11, 13]:

- News service, providing information about new courses and seminars.
- Tools for production of the course materials allowing the lecturer to place the material from a remote computer;
- Tools for communication among students and lecturers, among students, which are related with the work calendar and course materials.
- Subsystem of test preparation related with the work calendar.
- Subsystem of control – self-control, related with the work calendar.
- Subsystem of student identification and statistical data accumulation.

- Subsystem of registration of the user's actions.
- Subsystem of reports' generation according to various criteria.
- Subsystem of data backup.

3. Possibilities of the Lithuanian Virtual Learning Environment

3.1. Structural Parts of the LVLE

In [7, 8, 14] two main subsystems of the distance learning system have been singled out:

- Subsystem of development distance courses, meant for course planning, environment creation, presentation of the teaching materials, maintaining interaction with other distance learning courses;
- Subsystem of support a study process, meant for describing participants of the studies, process organisation, foreseeing clusters of independent studies, communication tools, and knowledge control. Knowledge control subsystem is meant for preparing knowledge control materials and their usage. The interaction of enumerated tools helps to evaluate the students' work and the time spent by the lecturer.

Besides, to solve distance learning system management tasks, two extra subsystems are necessary:

- Subsystem of execution organisation and control, which helps solving tasks of management of the process of studies and ensures safe work. It identifies registered users, analyses their rights, offers access to the objects of the environment, and ensures the safety of the used data and speedy data recovery opportunities.
- Subsystem of logistics, meant for planning the personnel, resources, finances, equipment and information of the institution. It supports information module meant to disseminate information about the possibilities of the system use. Another part of this subsystem is information support of study process, i.e. references to libraries and other information sources, especially full text resources and accumulation of local information resources in the system repositories. The user rights describe material access possibilities.

If support subsystems are not used, the personnel of the institution organising distance learning must perform all the above-mentioned functions.

On the basis of analysis of the structure of VLE, LVLE has been developed, the structure of which is presented in Figure 1.

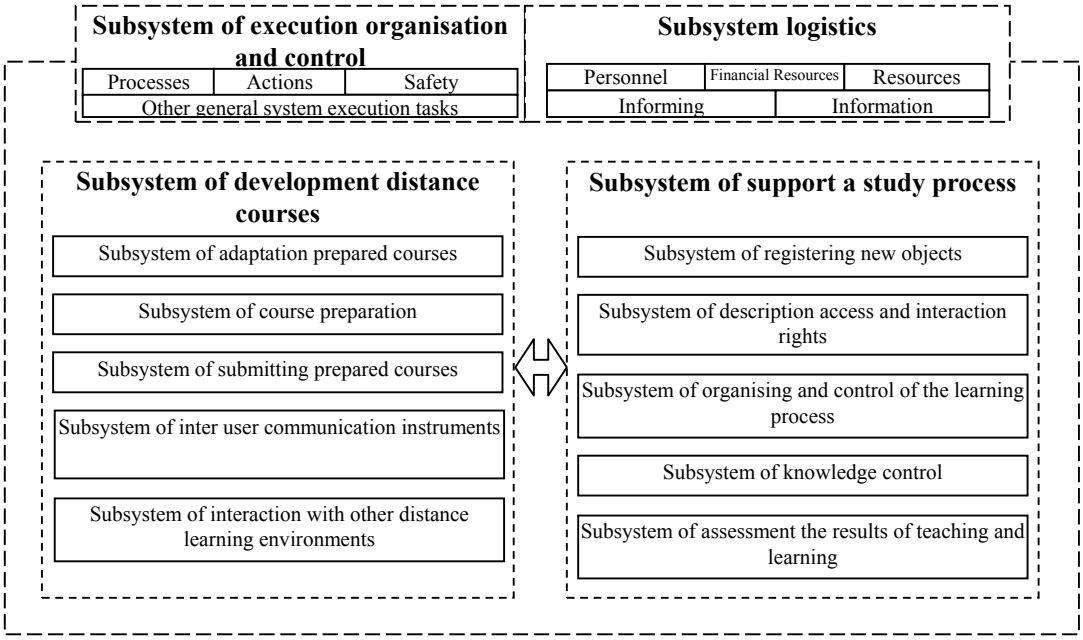

Figure 1. The diagram of the structure of LVLE

3.2. Tools for Implementing LVLE

To implement LVLE, the following free software has been used:

- Programming language PHP which supports object programming paradigm and has function libraries for work with network databases. The choice of language has been confirmed by TIOBE programming language communication index [4, 5], according to which PHP is allocated the 5-6th place:
- PostgreSQL network database. It is slower than MySQL but supports the SQL standard better. It is possible to carry out transactions, create views and triggers, and use internal procedures;
- Linux operation system has been used to provide LVLE services.

The data saved in the database are split into three parts: the first is users', their groups, permission data; the second is data about the courses, their structure, hierarchy, materials; the third is data about the activities of the users in the course, results and assessment. The designed database satisfies the third normalised form. To create LVLE, the object oriented design technology has been employed. Universal classes, designed to manage the system, made it easier to solve a number of management tasks.

3.3. Subsystem of Execution Organisation and Control

This subsystem ensures the user and data safety, employs encoded identifiers, saved in the data base tables. While creating the subsystem, network safety information has been reviewed and evaluated [3, 6], and additional requirements for passwords have been introduced with regard to recommendatios made by Scambray, Mcclure, Kurtz [7]. A hierarchical system of permissions has been developed and used which, depending on the user's rights, changes the user's environment and allows performing certain actions. The identification data of the registered user are described in the database according to the cryptographic encoding algorithm MD5. Special directives of the Apache server prohibit the access to the program code in the catalogue. Creation of backup ensures additional security of the data.

System users belong to a few major groups (e.g. lecturers, students, etc.), which are subdivided into subgroups and make up a hierarchical tree. Each subgroup has its own identifier and rights, which can coincide with the rights of another subgroup. The same user can belong to a few subgroups, acquiring additional rights respectively. The subgroups are given permissions to perform actions in LVLE systems the actions are checked by the subsystem of access rights control (Figure 2). In the case of prohibition, most often the menu choices, buttons, etc. are hidden. For each identified user a session is created during which its login name and encoded password are saved. When the page is renewed or a transfer to another page is made, the user is re-identified.

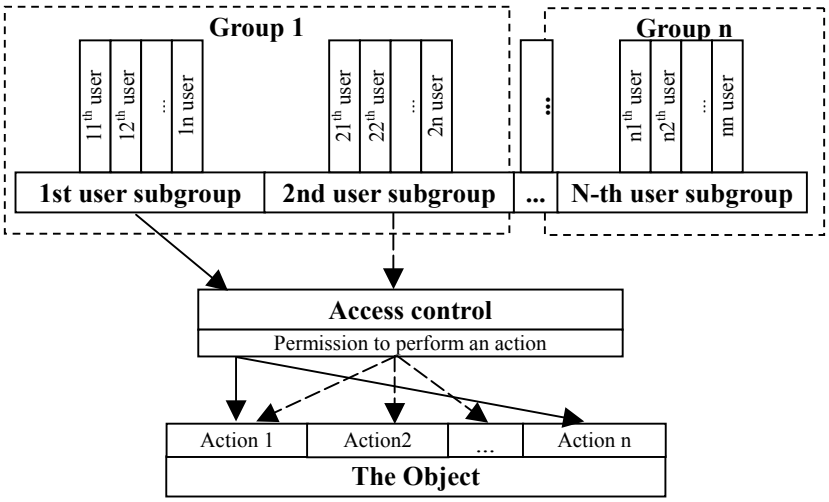

Figure 2. Subsystem of access rights control

3.4. Subsystem of Logistics

LVLE is divided into areas, in which depending on the rights, granted according to the user identification procedures, the work environment changes.

The elements of the subsystem are used in all the areas. Figure 3 demonstrates an overall scheme of the subsystem logistics, where an uninterrupted line shows information flows of unregistered users, while the dotted line shows those of registered users.

Any unidentified user can work in the collaborative area. It provides information about the events, new courses and foresees communication with personnel. The subsystem briefly describes the courses, their evaluation in credits and other important information for the student. It is possible to find out about provided services and visit the recommended references. New users register for a course via the registration subsystem. The system administrator carries out the control of the information recorded here, because it is difficult to create an intellectual expert system, which would properly evaluate the seriousness of the intentions and other parameters of the newly Registered person. The registration subsystem is connected with the financial analysis subsystem. Persons who are not enrolled with the institution using LVLE system have to pay a fee for their studies.

Only persons identified in the access control subsystem can work in the user area. They have the right to create and amend their course (most often lecturers). Here it is possible to write and correct advertisements, meant for unidentified users, carry out financial

analysis of the study process, put and edit materials for general use.

The users of the two main groups – students and lecturers (instructors) – can work in the course area. Students or users with analogous rights can only read information about the course and the lecturer's notices and go over to course area for studies. Lecturers and other analogous users may write notices about prepared modules, feed in information to the course info library, record and edit references to the useful sources of information.

The system administrator has been conferred the greatest logistic opportunities. He can introduce a new notices' classifier, a new department, foresee actions which are tolerated or prohibited in the system, register users who have filled in an electronic registration form, classify references. With the increase of the number of courses and users, it seems reasonable to distribute administrative tasks.

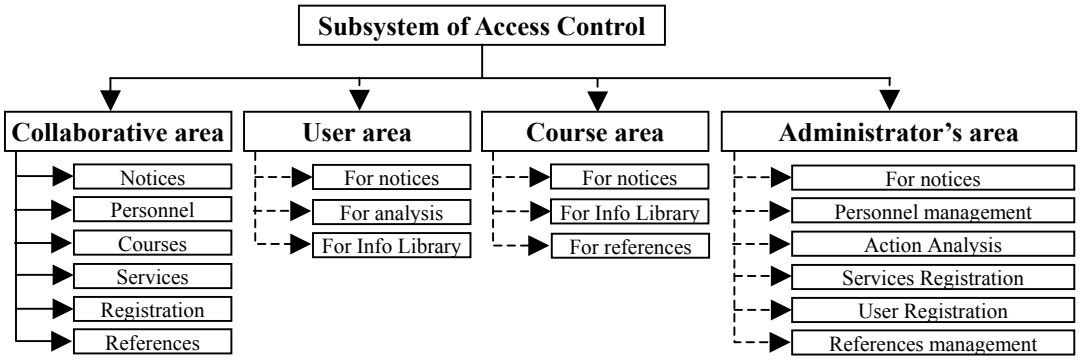

Figure 3. Overall scheme of the subsystem logistics

3.5. Subsystem of Development Distance Courses

While developing this subsystem, a detailed analysis of popular distance learning environments, meant for asynchronic studies (WebCT, LearningSpace, Black Board and others), and material supply subsystems was carried out. The works of Keegan [8], Targamadze, Normantas, Rutkauskiene, Vidziunas [20] about the peculiarities of material preparation and its presentation in virtual environment have been studied. The analysis of the works has confirmed that while preparing materials it is important to structure them properly and to use all possible inter user communication instruments for learning. That is why this subsystem includes material structuring, feeding in and editing tools. The subsystem is compatible with all popular information transfer formats. To activate the study process, a discussion subsystem and a work calendar have been created. The subsystem foresees tools for interaction with other courses and materials on the websites.

The subsystem is accessible only to registered users who have the right to create and edit courses. It consists of the three main parts: course preparation and material presentation tools, course support tools, and tools for interaction with other courses. If the author of the course has structured theoretical materials and put them on the website, s/he can form the theoretical part as an external course, while describe the process of studies in the LVLE system. It is possible to archive materials and then import them to the virtual environment. For structuring theoretical materials the author can use the instrument of creation of a hierarchical structure.

A discussion organising instrument with assignments transfer function sustains the dynamics of the study process. The course author can set the deadlines, which are dynamically linked with studies calendar thus introducing a tool for control of students' self-studies work. Records made in the calendar with regard to real time are published in the course news section.

3.6. The Subsystem of Support a Study Process

The subsystem of support a study process is characterised by the following modules: registration of the new objects, description of access and interaction rights, organisation and control of the study process, knowledge control, and assessment of teaching and learning results (Figure 1). Functional possibilities of the first three modules are reflected in the system administrator's use case diagram (Figure 4).

A new course, a group of courses, a student can be a new object. The right to create objects rests with course authors, administrators and their groups. Only users belonging to administrators' group can describe access and interaction rights and their usage rules. According to the described rights, it is possible to generate reports and carry out studies' analysis. The teaching process organisation module is closely related with information saving modules of the subsystem logistics, through which an access to virtual course libraries and external information sources is realised.

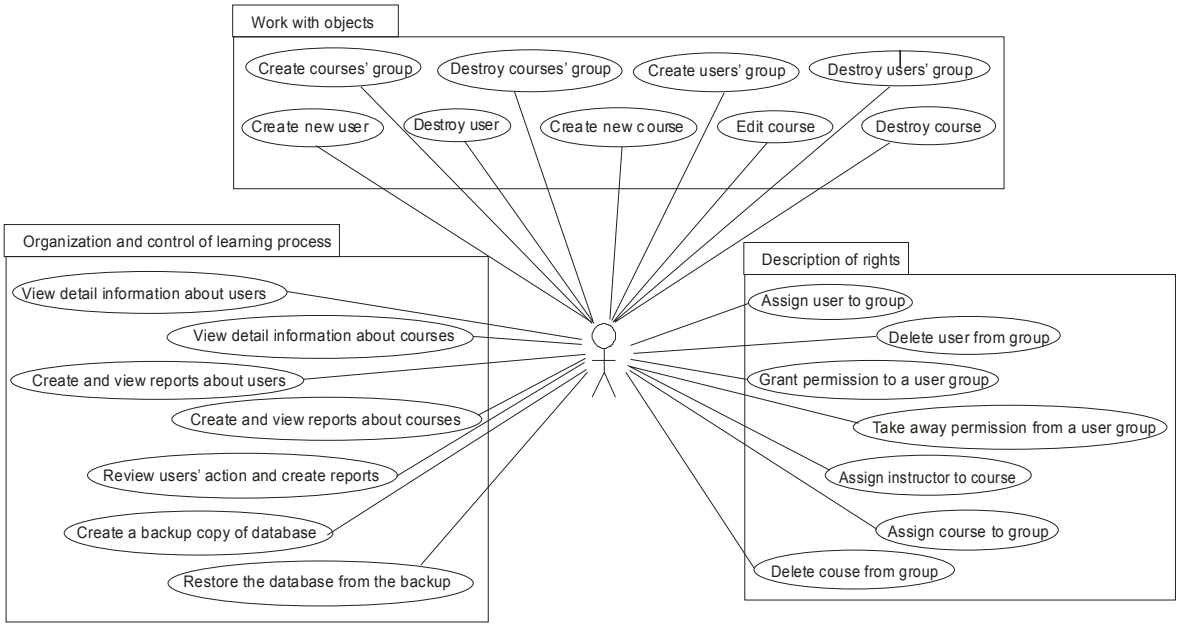

Figure 4. Administrator's use case diagram

Table 1. Possibilities of the testing module

Criterion	**What is implemented**
Test creation	
Test types	Evaluated tests Self-control tests
Question types	Multiple choice tests (with one or more correct answers) Open-ended tests
Question equivalence	Can be non-equivalent
Question importance	Exist. The importance of the question has to be changed if we want a few to be chosen from a greater number. More important questions are likely to appear in the test more often.
Question difficulty levels	None
Question explanation	None
Test presentation	
Random question selection	Possible
Random answer order selection	None
Time limit for performing a test	Exist
Time limit for access to the test	Exist
Test termination	Possible. If this is an assessed test the actual results are fed in the database.
Checking answers in open-ended questions	If while creating the test the correct answer is not provided, the lecturer will have to mark the work, in other case the checking is automatic. The comparison is direct.
	Feedback
Ways of declaring results	Is automatically produced in the "Tests" section. Every student sees only his/her own results.
Time of publishing the results	Results are announced after the test. Questions, which require the lecturer's marking, are marked as unassessed.
Completeness of the results	The final assessment is announced, mistakes are pointed out.

Knowledge control and teaching and learning results assessment modules are associated not only with the usual evaluation of student achievement in formal studies. The following can be assessed in the system:

1. Participants of the distance studies process: students, lecturers, technical personnel, administrative personnel.

2. Objects of LVLE on different levels: teaching materials: theory, tasks, tests, etc.; the course, LVLE as a system.

Oliver [15] argues that during the assessment one tries to prove that the objectives of the project have been achieved. Because the objectives of the projects are different, the results are also very different both in their form and content. According to Smith [18], very often "what is assessed is important to the assessor". While designing the system it was tried to provide opportunities to all the participants of the study process to assess. Lee [10] points out that assessment has to be holistic and the following has to be assessed:

- An influence on people and their relations;
- An influence on organisations;
- Educational results;
- Technical aspects.

Tests are among the most often used forms of assessment in distance learning courses. The possibilities of other VLEs to create and present tests have been thoroughly analysed. Educational aspects of testing have also been examined. The possibilities of testing module are structured in Table 1.

The software and the possibility of automatic assessment have determined the choice of the type of questions. In other environments the usual Yes/No type questions can be implemented as multiple choice questions by pointing out respective answers. Special software is used to create matching questions and so far they are suitable only for self-control. Questions and tasks of all other types have been created by using Java applets, Flash or other technologies and can be integrated by using course development module.

In usual VLEs it is not possible to establish the importance of the question. In our case such a possibility is foreseen. One can choose out of five necessity levels. This determines the probability of the question appearing in the test.

Baniulis and Reklaitis [2] while introducing the testing system *TestTool* emphasise that "the only way to achieve academically credibility of testing lies in radical changes and introduction of new forms and types of test questions". Their testing system is geared towards teaching technical disciplines. In it graphical construing questions are presented as offering an opportunity to go one step further up in Bloom's taxonomy. In our opinion, assessment validity in distance studies is ensured by the accumulative assessment and introduction of the new ways of assessment. Functional possibilities of the distance course development subsystem – feeding in one's own work, critiques, etc. – should be employed for assessment.

3.8. Development possibilities of the LVLE

The functioning of the LVLE has been tested, by using experimental data and various possible scenarios. The remarks and wishes of users are being collected. The results demonstrate that the project has achieved its aims. However, further system development opportunities are foreseen to ensure its development in both technological and educational aspects:

- Optimisation of the information flows of the system:
- Development of the finance and resource management module of the subsystem logistics;
- Development and optimisation of interaction of learning process organisation and control and assessment of learning results modules of the subsystem of support a study process;
- A fuller integration of elements prepared with other tools (with data flows implementation between the created system and integrated elements);
- Improvement of registration procedures.

4. Conclusions

1. An overall structural scheme of VLE is formulated on the basis of the analysis of the structure and functions of the VLE.
2. The designed LVLE has structural parts of the overall system of distance studies.
3. LVLE is fully functioning; development areas of LVLE are foreseen.
4. LVLE communicates with the users in Lithuanian.

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