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Improvement of Quality of Education Using E-Learning Environment

Abstract: *eLearning with its tools such as web laboratories, LMS, on-line courses, becomes milestone in concept of University education. In this paper we will present organization and development of eLearning educational environment developed in CIM center, Faculty of Mechanical Engineering in Kragujevac. This eLearning environment consists of Learning Management System, on-line tests and web laboratory. We will also present initial results of implementation of this integrated eLearning environment in engineering education.*

Keywords: *eLearning, quality, education, web laboratories*

1. INTRODUCTION

We are witnessing an integration of European educational system in the last 10 years On the other hand development of information technologies brings new possibilities to education. A new concept of education arises. One of the new concepts is eLearning. ELearning most often means an approach to facilitate and enhance learning through the use of devices based on computer and communications technology. It is undivided opinion that eLearning is one of the corner stones in the European educational structure. Many important convention, declaration and communiqués are dealing with concepts of open distant learning and eLearning (Lisbon convention, Sorbonne, Bologna declaration, Prague, Berlin, Bergen communiqués, look in Stefanovic et. al. (2006), Dondi C. (2005)). The ODL Liaison Committee Policy Paper "Distance Learning and eLearning in European Policy and Practice" provides a short overview of visions of eLearning during recent years and a summary of EU policy achievements and shortcomings. The main conclusion is unambiguous: *"... to make Europe the most competitive and socially inclusive economy in the world by 2010 was defined the need to include education and training as a key component of the Europe Plan was immediately perceived. At the same time it was recognized that the existing education systems in their traditional roles would not be able to cope with this need. An eLearning Initiative was therefore proposed shortly afterwards..."*. Following this major concept Faculty for Mechanical Engineering started with development of integrated eLearning environment. In this paper we will present organization and development of eLearning educational environment developed on Faculty of Mechanical Engineering in Kragujevac. This eLearning environment consists of Learning Management System, on-line tests and web laboratories. We will also present initial results of implementation of this integrated eLearning environment in engineering education.

2. PRE-REQUESTS, ARCHITECTURE AND SOFTWARE REALIZATION OF ELEARNING ENVIRONMENT

Integrated eLearning environment (IELE) developed in CIM center, Faculty of mechanical engineering in Kragujevac consists of: eContent Management System for educational

material, on-line tests and web laboratory. We used traditional Content management system for management of educational content. We have planned to implement Moodle software solution for improvement of this part of integrated educational system. On-line tests are developed in the form of multiple choices. We implemented some security actions in order to prevent potential problems by recording session ID, IP number and implementation of access management module with logging function.

Considering other relevant experiences and solutions in development of the web laboratories [Casini M., et. al. (2004), Guran-Postlethwaite Y., et. al. (2005), Forinash K., et. al. (2005), as well as the character of the planned laboratory exercises, the team that started development and implementation of the web laboratory of University of Kragujevac defined following requests for the software infrastructure of integrated eLearning solution:

a) Requests for content management system:

- Adjustment of teaching material to the new context. The concept of distant learning demands adjustments of teaching materials and overcoming of problems that appears due to the physical absence of lecturers. Educational materials that are added to specific laboratory exercises, as theoretical background, should be organized according to the appropriate standards for e-Learning, SCORM standard. Easy understanding of educational tasks and user friendly interfaces for laboratory exercises. Since students perform laboratory exercises alone, independent of time and location, they have access to the laboratory equipment, and during that process, they do not have the support of professors and laboratory stuff for additional information, the complete system for the web laboratory must be extremely user friendly, interactive, with quality help files and complete support. So all advantages, and multimedia character of the web environment, must be utilized in addition to the number of sections for support, educational materials, comments, forums, FAQs.

b) Requests for web laboratory:

- On line presentation of an experiment. In order to achieve educational purposes, it is very useful that students have full insight of all phases of an experiment. A high level of visualization is important request, starting with the initial presentation of the system, characteristics of the system, and complete monitoring of the experiment. This request could be fulfilled by installation of a server for video streaming and highly graphical based user interface.
- Environment for easy definition of the control algorithms and control signals. We have accomplished these goals by giving examples for download for the control algorithms and control signals. Students have previously defined examples of the control algorithms and control signals for their exercises and analysis. We also provide graphical, user friendly interface for selection of the control signals and intuitive set of steps for definition of the control algorithm.
- Laboratory exercises and all results should be stored in a database. One of the strengths and advantages of this system is a database with stored experiments and results. Users could search this database for specific solutions, or they could compare their solutions with previously approved solutions. This database enables better analysis and cooperation on one hand. On the other hand, it enables multiple checks and higher individualization of each experiment. We have used MySQL database as a logical choice for our environment, to store all results of performed laboratory exercises, and to store all developed control algorithms and input signals. This database enables professors in the later phases to analyze each laboratory experiment and it gives a suggestion in order for a user to improve the control algorithm or to test the system with other input signals.
- Download of experimental results. Beside records in the database, a user could download results of a laboratory experiment. Using this downloaded results, a user could

make different reports or analyze his/her work. Results of all experiments could be downloaded as a file.

c) General requests:

- It is necessary to select appropriate software platform and appropriate security police. In order to achieve this, we have selected an open source environment, Apache web servers, and we have developed a module for the access management for the full control of users' access according to the authorization level. We defined two general user groups: admins and users.
- It is necessary that client software operates on all available software and hardware platforms. One of important demands is that the system, on the client side, must be platform independent. Using the standard web browsers on the client side, we solve this problem, as well as problems with installation of the software on the client side, because a simple Firefox browser could be used for a client. Using the standard web browser, we accomplished another important goals, software on the client side is free (as well as software on the server side, because we used an open source environment), installations of the software is quite simple, and security is considerably high.
- Management of changes and distribution of new versions. The web application enables this concept. We have selected three-tier architectures, so application is easy to change.
- System must posses modular and open structure so new component and laboratory experiments could be added easily. IELE is designed on the basis of the modular and open principles, so it is very easy to add a new experiment or content. In order to achieve this, the web lab is based on Content Management System that gives opportunity to lecturer to use simple administration panel to add a new content. IELE is an open modular system and it is planned to grow and develop with addition of a new content or with development of software or new technologies.

It is clear there are number of additional important demands and requests for quality organization and development of eLearning environment. The listed demands were a starting point of this group of authors in organization and development of this specific solution. These demands are possibly the most appropriate to the engineering education, and it is highly possible that other fields of education have partially different demands.

In order to achieve listed demands, we selected an appropriate software architecture. The software architecture consists of two major parts: the first part that controls physical processes (on the server side server – Control Server) and the second part that controls user interface and defines user access (also manages with other functions and parts of e-Learning environment) oriented towards user service (Web server) (Figure 1).

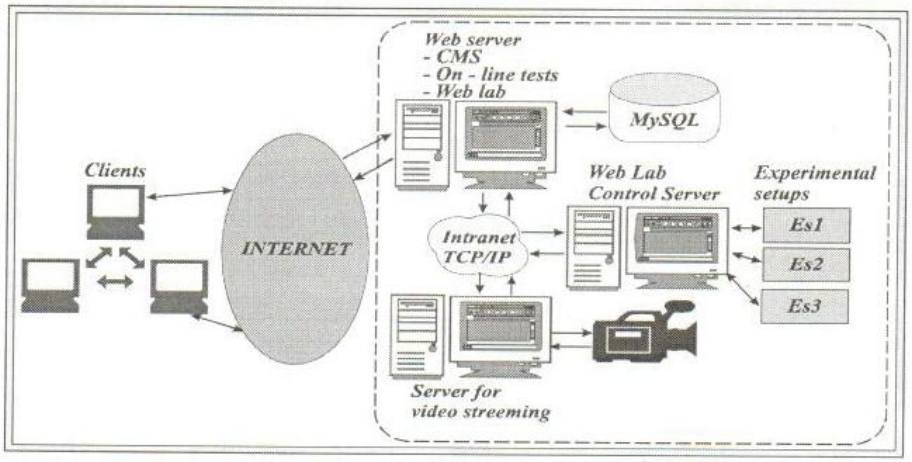


Figure 1 – Architecture of the system

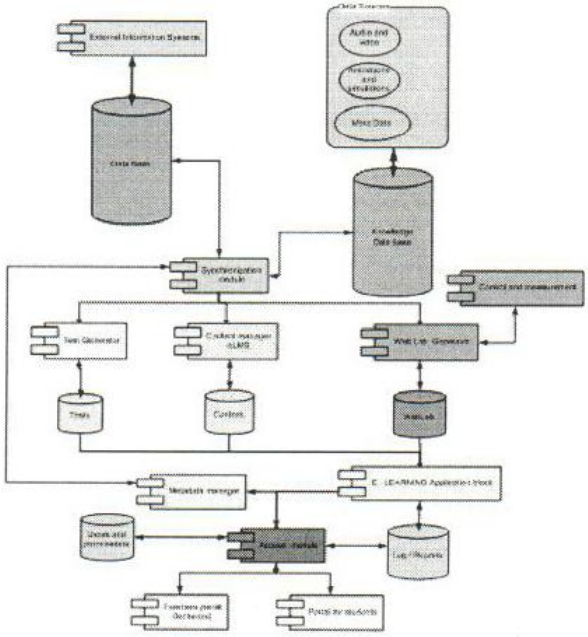
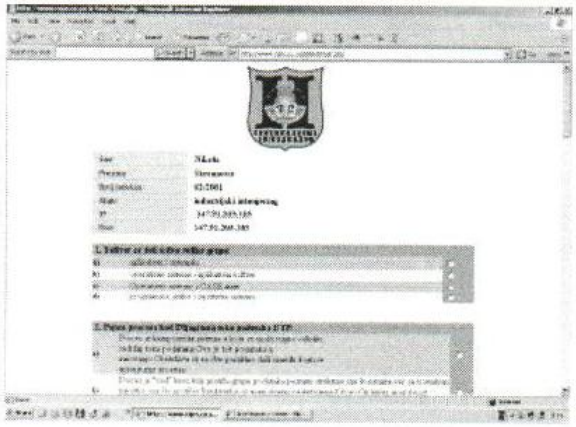
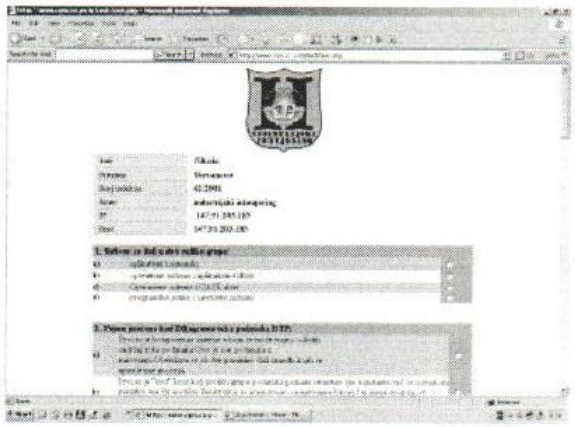


Figure 2 – UML diagram of integrated e-Learning environment of IELE





The control server is developed using programming language Delphi. The software module – the software interface for implementation of the control algorithm and communication with the web server is located on the local control server. The system for data acquisition and D/A converter are connected with this server.

The client side is base don dynamic pages generated from PHP or ASPX (the reason for this duality is the fact that telemetric exercises are hosted on the IIS server using ASPX and laboratory exercises in the field of automatic control are hosted on Apache server using PHP). All information about experiments, user access and other relevant information connected with e-Learning environment are stored in MySQL data base.

The last planned server is the video server (in the implementation phase right now). The video server supports broad streaming of the video signal. This server has a task to establish a visual „feed back" and to create real impression of an experiment to potential users of the web laboratory.

The integrated e-Learning system, with web-based laboratory as an important part is presented in Figure 2. The main idea is the development of the integrated e-Learning solution which enables management with the educational materials and presentation of the course using LMS (Learning Management System); self-evaluation and evaluation using module for e-tests (figure 3) and practical experiments in the web laboratory (figure 4). This e-Learning environment improved education processes and produces a "blended" education environment. The combination between the classical education and the e-education on faculty of Science and Faculty of Mechanical Engineering University of Kragujevac.

We have also planned a module for synchronization for interconnection of the - Learning system with other education information systems and extern knowledge basis.

3. INITIAL EDUCATIONAL RESULTS

The presented eLearning solution withweb laboratory and other parts of the integrated environment for education, became a part of the education process during the year of 2006 on Faculty of Science and faculty of Mechanical Engineering. The web laboratory is presented to students from departments of Automatic Control and Industrial Engineering

Table 1 – Character and organization of web laboratory

No	Question	Mark				
		1	2	3	4	5
1	Task is clear			17%	26%	57%
2	Educational goal is well presented			27%	25%	48%
3	Exercises are accompanied with appropriate theoretical content			25%	30%	45%
4	System is reliable		16%	18%	32%	34%
5	System is easy to use		5%	15%	28%	52%

Table 2 – Students' questionnaire – Effects of implementation of eLearning

Effects of implementation of eLearning	Mark				
	1	2	3	4	5
System provides better training					
Multimedia character of course					
System makes laboratory exercises easier					
Decrease time of preparation for laboratory exercises					
Improves organization of course					
Improves character of lectures					
Stimulation for students					
Gives better information about course					

Table 3 – Indicators of usage of integrated environment for e-Learning

Title	Number of access to IELE	Average mark of users' satisfaction	Average mark of users' satisfaction [1)]	Oregon Institute of Technology [2)]
Web Laboratory	526	4.13	2.99	3.00
On-line testing	3237	3.71	-	-
On-line material	-	3.40	3.03	-
Virtual seminar	-	-	3.07	-
1) Niederl F., et.al. (2006) 2)Guran-Postlethwaite Y. et. al. (2005) (mark 1-5)				

form Faculty of Mechanical Engineering. Students used the web laboratory and on-line tests during the educational process and filled on-line questionnaire in order to present their experience and evaluate benefits from the web laboratory, the results are presented in Table 1. The positive response from the student population was undivided; they highly evaluated organization and character of the web laboratory and eLeraning environment. The students accepted this educational tool and responded with the main answer that the web laboratory fulfilled planned educational goals, and they completely understood laboratory experiments goals and tasks of exercises. The students also pointed that the system is user-friendly, and easy to use. The students were also encouraged to give their conclusion about the effects of implementation of the eLearning solution. The results are gathered, grouped and presented in Table 2. It is important to emphases that there was no negative reaction, and more important conclusion is that the eLearning contributes to better and more quality understanding of the educational material.

Other similar researches have similar results. For example, Universities Australia concluded: "Virtual experiences are valued for their flexibility of use, availability for revision and provision of additional information, whereas real experiences are valued for the hands-on, 3D nature but also for their 'reality' (Franklin S., et. al. (2005))".

This approach to education was accepted and highly evaluated by students, results in Table 3. Comparing Austria University and Oregon Institute of Technology, the students satisfaction is better, but this is a result of higher motivation of the Serbian students because they usually do not work with modern on-line educational resources, so our students highly evaluated the initial steps in that direction.

These results encourage us to continue to develop the IELE and to interconnect our system with other similar systems.

5. CONCLUSION

The expansion and development of information technology, enables usage of new, highly-quality education systems much different than the traditional systems. In the concept of e-Learning we have many different tools such as: Learning management systems, web laboratories, e-tests.

This paper describes education advantages, organization, realization and educational effects of integrated eLearning solution developed by CIM center, Faculty of Mechanical Engineering.

The implementation and usage of integrated web lab and eLearning environment improved quality of education process in many different ways:

- System is accessible 24/7. A student time is personalizes, e.g. students may freely plan their study. The analysis of access information of the system shown that we have access to web lab at any time, maximum is between 22.00 - 23.59 - 11.8% so total

visits, and minimum is between 06.00-06.59 – 1.6% of total visits to web lab.

- Physical presence of students is not mandatory in the Faculty building. This is very important because enables concept of distant learning and enables permanent education of people who are dislocated from university and educational centers. Almost 1/4 of accesses to the web laboratory and eLearning system were made out of region of Kragujevac, where university is placed.
- Optimal utilization of resources. Increasing of availability of the laboratory equipment and full access to the laboratory no matter of location leads to better utilization of laboratory resources. The analysis of accesses to the web lab shown that 27% of accesses were made from academic network, and 73% of accesses were made from outside access nodes. This rationalization in utilization of laboratory resources leads to lower expanses.
- Better preparation for experiment. The access to the laboratory equipment and theoretical content, as well as the previous experiments, offer better preparation of students for the experiment. Student could individually try and repeat experiment as many times as they need to prepare. According to the analysis of the access information, we determinate that each student perform specific experiment 5.1 times in order to improve his/her knowledge or to check his/her results.

  Elearning environment is a very important for the concept of permanent education for all employed and unemployed persons. People with special needs could use resources of the elearning system and have the same opportunities as all others. Distant learning and the web lab make them equal in the education process.
- Initial results of the implementation and usage of theeLearning system have shown that this education approach has great motivation and education effect, and improve organization and quality of education (table 1-3).

  The analysis of students' feedback show that students highly evaluate this approach in engineering education. The feedback from users has been quite positive, and the convenience and ease of use of the system have been universally appreciated.

One great advantage of this web lab is fact that this lab is part of an integrated e-Learning environment. Students have theoretical content, practical work in the web lab and opportunity for self-evaluation using e-tests. Everything mentioned above emphasize importance of dynamic e-Learning environment and high potential of web laboratories.

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