# Personalized Learning Environment E-CHO

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**Abstract.** Important features of the Knowledge Management Systems, based on the Information and Communication Technologies (ICT) are described in the first section. These features emphasize the importance of Web 2.0 concepts which foster user generated content development as well as effective content filtering and selection capabilities (e. g. Really Simple Syndication – RSS feeds). The most popular community portals (blogging, video, etc.) nowadays generate more content than ever before. This new paradigm, where users become active participants instead of passive observers, calls for improvements in quality assessment and demands the adaptation of user generated content, so that it could be used for the wider interested audience. On the other hand, corporate or academic environments do not benefit from the community oriented Web 2.0 advantages directly. Knowledge Management challenges in these environments lie in the meaningful and tight integration of the Learning Management Systems (LMS) into the existing knowledge resources and information systems. This enables creation of personalized learning environments for target users, which is described in the second section. Subsequently, some of the case studies, which are incorporated into the E-CHO Learning Management System at the Faculty of Electrical Engineering, University of Ljubljana, Slovenia, are presented. Conclusions of the paper describe future research and development work, based on our experiences and new learning paradigm, putting learners into the centre of the educational process.

## Introduction

Introduction of e-learning into any business or academic environment facilitates studying activities as well as management and administration process. E-learning assists in extension and deepening of student's access to information, increased flexibility of study delivery and integration of student's learning experiences and knowledge. Aspects of e-learning initiation that are not directly correlated with the studying activities are also important. Students save time and money that would otherwise be spent on travelling and accommodation expenses. Faculties with enrolment limitations due to lack of space (lecture rooms, laboratories, ...) can increase the number of enrolled students.

Because all learning materials are in electronic format, their upgrade, maintenance and distribution can be substantially simplified. This is significant in the natural and technical science studying fields where knowledge is modernized and upgraded all the time. Simplified distribution means the increase of use of the same learning materials in different faculties and studying programs. Systematic e-learning introduction also enables better time efficiency in the engagement of the pedagogues.

E-learning should reflect actual education process in academic environment and enhance educational possibilities in innovative way from the viewpoint of the course access, contents and level, in order to meet diversified needs of target groups. The only way to accomplish this is to support the following e-learning components:

- E-learning content commonly presented in HTML format, enriched by multimedia that is sup-ported by Internet as well as real time audio or video streaming clips. Java applets are usually used to explain experiments.
- Management of the learning process consists of managing students, learning staff, learning content, different learning tools and dissemination of learner's statistical data as well as progress tracking.
- Collaboration between learners can be accomplished by forming of groups of learners, giving them common assignments and enabling them to have guided or non-guided discussions among themselves.
- Pedagogical support is achieved through tutor - learner communications via advanced communications channels. These can be asynchronous: e - mail, discussions and notice boards, or synchronous: chats or audio & videoconferences.
- Assessing knowledge in e-learning is not only about getting feedback on the learner activities and gained knowledge, but also about acquiring complete picture of the quality of e-learning. The most common model

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to achieve this is through multi-level evaluation. This way we evaluate reaction of the learners, track learners progress and get the results of e-learning.

E-learning as described (in different variations) has been present for more than ten years or so. During that time, it has emerged from being hype to the mainstream ICT supported service in academic and corporate environments. Learning content that is used in e-learning today is represented in the set of learning objects that originate in the computer-based training (CBT) system. These are the smallest possible, independent, sets of content that could be put together or organized. Standardization bodies have redefined the concept of learning objects into a strict form and have provided specifications on sequencing and organization of learning object into online courses or course packages similar to e-books or training manuals. Therefore, the main software used in e-learning today is the Learning Management System (LMS), as described above. It organizes learning content in a standard way, as an online course separated into modules or lessons, supported with quizzes, tests, communication and collaboration features, mostly discussions. Most up-to-date LMS systems are integrated into the target environment information system.

However, internet as the main media used in e-learning and its users have begun to change rapidly. Some authors say that internet users are becoming »digital natives«, meaning, they learn, play and work in completely different ways [1]. Their most important features are quick and easy absorption of information presented to them, from multiple sources simultaneously in different formats (images, video text, etc.). The speed at which digital natives perform is faster than previously, additionally they expect instant response or feedback. They expect to be in constant and instant communication with their friends, they prefer accessing information on the random (or as needed) basis from different media or sources and they are very likely to create their own multi-media content. In learning, these trends can be described as the »Learner Centered« design [2]. This means that learners are put in the center of the learning process, where teachers act as moderators only. Learning today emphasizes greater autonomy for the learners and fosters active learning, with creation, communication and participation playing key roles [3]. Some authors speak about “connectivism” in learning [4]. Siemens states that today’s knowledge workers derive competencies through formation of connections in the chaotic world. Connectivism is in accordance with the well-known constructivism theories in the learning which foster understanding through process of meaning and constructing (making) afterwards. Meaning-making process and forming connections between specialized communities are both important activities. To clarify these statements we can look into modern internet services, commonly called “Web 2.0” and used in e-learning. Web 2.0 itself was transformed from "the Read Web" to the "Read-Write Web" [5]. Web changed, from being a medium, in which information was transmitted and used, into a platform, in which content is created, shared, repurposed, and passed along. Users are no longer merely reading, listening or watching, but having a conversation, not just with words but with images, video, multimedia and any other way. Evolving Web services, described in the subsequent section and used in e-learning are called Web 2.0 services.

As an example we can look more closely to the simple file sharing among users. According to different studies [6] users believe that information (set of documents) is something meant to be shared. This belief is manifested in free and open-source software, Creative Commons licenses for content and open access to academic and other works. Sharing content is not considered unethical; on the contrary, keeping the content is viewed as antisocial. Blogging as another example changed from the static web pages into a service used by many users, supported by easy content creation tools (e.g. Blogger, WordPress) and more importantly, connected to each other through the means of RSS feed, that is, simple XML (Extensible Markup Language) format enabling sending of the content to the readers (subscribers). Creation of online communities using specific tools (e.g. Plone, Drupal), use of online collaboration tools, such as Wiki (*http://wiki.org/wiki.cgi ?WhatIsWiki*), audio re-cording tools (e.g. Audacity) and other simple means of content creation fostered user generated and connected content, even more. We can see, that when speaking about Web 2.0 services it is not about technological revolution, but about social revolution. We are also not speaking about net-works in technology terms, but about “Social Net-works” [7].

In the e-learning, social networking is most obvious in building communities. Etienne Wenger [8] promotes “Communities of Practice”, which are characterized by "a shared domain of interest" where "members interact and learn together" and "develop a shared repertoire of resources". In e-learning discussions are known for a

longer period of time in the form of structured post-reply format. Internet forums, embedded in the e-learning systems are most commonly used. However, lately, authors of this article noticed that students of the Faculty of Electrical Engineering in Ljubljana, for example discuss a wide range of topics with their peers worldwide in-stead of using pre-assigned forums and topics with their faculty peers. Additionally, Web 2.0 services, such as blogging are more and more commonly used in education process (e.g. *http://www.ebn.weblogger.com*) for wide variety of purposes, as they tend to be different from traditionally assigned content in the way that they are less formal and written from the personal point of view. It is expected that e-learning software in the future, such as LMS and other systems used are going to become less and less content delivery systems but more and more content authoring tools, where content and learning is going to be created. Systems used in e-learning will represent one of the nodes in the web network of content. These systems will not be applications installed and maintained by a target organization or company exclusively, but will become personal learning environments, a collection of interoperating systems, adapted to the learners' needs and interests.

### Knowledge management and e-learning

The knowledge management aims at managing knowledge assets (tacit and explicit) in the target environment so that all the information is available when it is needed and to those who need it [9]. Knowledge management should help those acquiring information to find new creative ways of solving problems in the changing environment. When compared to e-learning as described in the previous chapter, one could assume that knowledge management is only a new name for modern e-learning process. However, there are knowledge management features that are not covered within the core e-learning process. These features concern means of adding new knowledge into target environment knowledge pool [10]:

- externalization of tacit knowledge into explicit knowledge;
- socialization among workers (it increases tacit knowledge);
- "interiorization" of explicit knowledge into tacit knowledge;
- combination of explicit knowledge training processes.

There is an increasing need of managing knowledge in the target organizations, as they usually represent closed environments and need new knowledge also through external factors. What used to be tacit knowledge held by individuals can be made readily available to others, thus increasing the organization's knowledge base [11]. As an example of usefulness of knowledge management integration into e-learning process are skill or knowledge gaps that target organizations may encounter. These are gaps between what the target organizations need in order to face new challenges and the notions users (students, teachers or employees in corporate environments) can make available to the pursuit of such projects. In order to overcome the skill gap, corporate environments especially, need to map all the skills and competencies that each employee owns. Additionally these skills need to be analyzed in order to prepare the training or e-learning plan for example. Along with the presented problem there are other issues and challenges that make knowledge management and e-learning common introduction in the target environment reasonable. This can be done by adapting the Learning Management System used. Adaptation consists of LMS integration into existing applications of the target environment and additional analysis of the data necessary.

Finally, we can see that the development of up-to-date e-learning application derived from an LMS consists of two contradictory tasks. The first one is integrating an unstructured combination of differ-ent applications used in the modern e-learning, presented in the previous chapter of the article and the second one is integrating structured and organized applications in order to support knowledge management processes in the target environment [12]. Both tasks are difficult to achieve. At the Faculty of Electrical Engineering we have developed an LMS that will be presented in the subsequent chapter of the article. Through an iterative process of adapting our LMS we are trying to meet the objectives of the modern e-learning as well as to support the knowledge management in the target environment. However, there is a long way to achieve both tasks and many more implementations will have to be performed in the future in academic as well as corporate target environments.

## 1 E-CHO learning management system

There were several reasons that led us to develop and implement our own learning management system. Commercially available e-learning systems can be di-

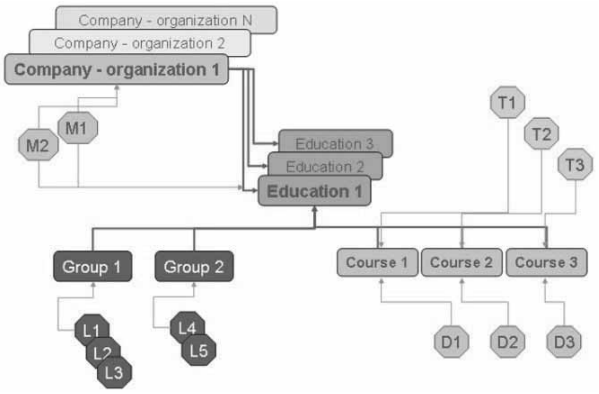


**Figure 1**. The top view of the model on the surf.

vided into two groups. The first one consists of the systems that support required e-learning prerequisites and can be functionally verified. These systems tend to be too complex to use and too expensive to purchase, especially for the smaller and medium size target environments. The second group consists of mainly open source systems that support e-learning components partially, but are difficult to be adapted to the specific needs of target environments or to be integrated with knowledge management features needed [13]. However, main reasons for the implementation of the e-learning system reside in the constraints and challenges that emerged from our practical implementations of e-learning.

### 1.1 Basic features of the system

The name, given to the e-learning system, discussed in this article, is E-CHO. System enables multilingual user interfaces, as well as course catalogue creation. Different roles of users were deter-mined in order to define the level of access rights to the system. The authentication and authorization rules disable unauthorized proceeding among different roles within the e-learning system.

The system enables access to course content for the learners, creation of personalized courses. Pedagogical and administrative support during e-learning is also supported.

Tracking learners' progress as well as different statistical reporting is an important feature of the system in order to provide the full learning experience.

Readers who are interested in the real e-learning environment, based on the E-CHO system can log on to the *http://www.e-cho.org/* web page, where the e-learning implementation for the Faculty of Electrical Engineering at the University of Ljubljana, Slovenia can be experienced. The E-CHO e-learning system was implemented at the national fixed telecom operator, national mobile operator in Slovenia as well as in the biggest Slovenian bank for the internal employee training. Currently, there are more than 20000 users learning via the E-CHO e-learning system.

### 1.2 Understanding E-CHO

The e-learning system is an internet based application. As such it can be integrated with any other internet or intranet application that would be potentially used for education purpose.

Education and training of employees, customers, students, etc. is often closely related to the business process of the target environment. The e-learning system is designed in a way that simplifies the integration with the existing information system of the target environment. It usually serves as the part of its information system.

Three main guidelines were set up during the functional specification of the e-learning system:

- simplicity of use
- system independent course content creation
- personalization of the learning activities

Main features of the system are Learning Management System (LMS) and Learning Content Management System (LCMS) [14].

### 1.3 Learning management

The use of the LMS is almost inevitable, as soon as the e-learning consists of different groups of users and different knowledge requirements. For larger corporate or academic environments, flexible and easy to use LMS is necessary [15].

The system enables access to the learning content, joining of users into groups, administrative and pedagogical support of the learning process as well as acquisition and tracking of the learning progress data.

The following main entities of the system were defined:

- *users* can have one or more different roles in the system
- *courses* are complete series of content building blocks, pedagogically and technically suitable for e-learning delivery
- *learners* enable flexibility and simplicity of the learning management process

Figure 1 presents entities of the system. We can presume that the system is installed at the Learning Service Provisioner (LSP) [16]. The top entity is 'Company (Organization)'. Several of them can use the system on

the same server separately. 'Companies (Organizations)' create 'Educations', the core entity of the system. Each 'Education' consists of one or more 'Courses' and one or more 'Groups' of users.

All users access the e-learning system through specific user interfaces over the internet browser. Due to complexity of the e-learning, transparency and adaptation requirements, system distinguishes five types of users: learners (L), tutors (T), developers (D), managers (M) and system administrator.

One can be registered in the system as the member of different types of users at the same time.

Managers' work in the system is related to organization of the e-learning. In classical education or training activities, his work is done by the administrative workers in the student departments of the academic environments or human resources and training departments of the corporate environments.

### 1.4 Learning content management

Content represents the most important component of e-learning, thus it has to be rich in multimedia, interactive and pedagogically appropriate. These conditions require system or platform independent content development. Content developers should use arbitrary tools for development, according to the needs of the content. They shouldn't be limited with any compulsory content development tools by the e-learning system that is used for content delivery [17].

This approach to content development increases the portability of the content, as long as it is being developed in any of the standardized internet format.

The e-learning system discussed enables importing of any internet based content. The content is usually represented as a series of HTML pages with belonging media building blocks.

The role of LCMS is to develop courses from the imported raw content. First the course building blocks have to be distinguished, sorted into series, then the levels of the building blocks have to be defined. This way the table of contents of the course is created, similarly to the table of contents of the textbook. Subsequently studying tools for the course have to be defined. There are several of them integrated within the system (e.g. user notes, dictionaries, calculator, adding favorite links, etc.), others can be added by integrating any existing internet applications, used for learning.

Course developers can add standardized meta data about the course from which the course catalogue can be created.

Navigation and personalization of the e-learning is achieved by creating different suggested studying paths, adapted to the specific needs of learners or groups of learners. In this way learners access and navigate only through the course building blocks of their interest. The course content is manageable and personalized from the learners' point of view.

The usage of arbitrary content search mechanism on the server is possible, due to e-learning system independent content development.

Assessments from the external knowledge assessment server (e.g. QuestionMark Perception) can be added to the course, thus enabling pre-tests, self-assessment tests and post-tests.

### 1.5 System architecture

System is based on the widely used Microsoft technologies. System software consists of: operating system on the server (Microsoft Windows 2003 Professional), database server (Microsoft SQL 2005) and internet server (Microsoft IIS).

Functionality of the system is implemented with three tier object architecture. Business logic layer is made up of two sub layers, therefore the term four tier architecture can be used [18].

Database layer is implemented with the MSSQL Server 2005 database. Stored procedures are used for data retrieval. Format of data retrieved to the business logic layer is XML. Chosen technology enables integration and synchronization of the e-learning system with existing information systems and Lightweight Directory Access Protocol (LDAP) directory services.

Business logic layer consists of Component Object Model (COM+, ActiveX) objects, arranged into classes. Classes are made up of number of methods.

Layer provides for calls of stored procedures, accepts requests from the presentation layer and re-turns corresponding data. It is also used for business logic operations of the system, such as computing statistical data, learners' progress tracking, etc. Layer is divided into two sub layers. The application (APL) sub layer processes requests of the presentation layer and provides data to it. Database (DB) sub layer, on the other hand provides for communication with database layer (collecting and entering of data). DB sub layer simplifies the migration to different databases.

The Business logic layer is implemented as two Dynamic Link Libraries (.dll) files, that have to be in-

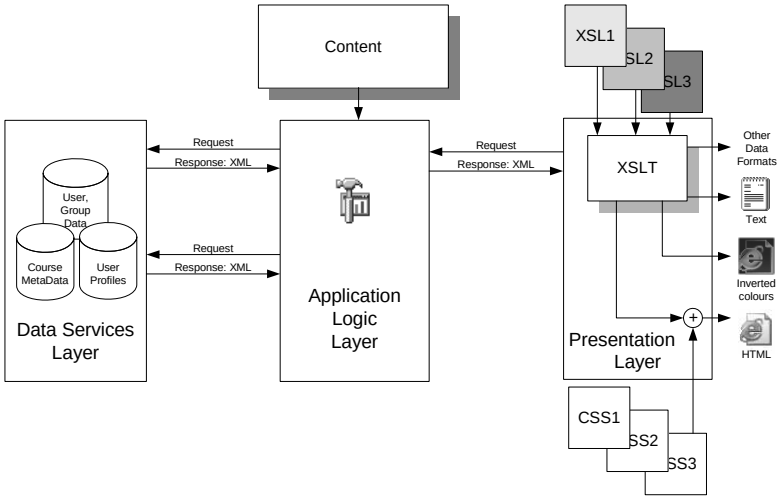


**Figure 2**. E-CHO system architecture and multi-modal presentation of content

stalled, to the IIS WWW server.

Presentation layer uses XML (Extensible Stylesheet Language - XSL files) and Active Server Pages (ASP) technology that are both embedded in IIS server. ASP files are used for calling corresponding objects of the business logic. XSL files that define appearance of the user interfaces acquire data needed from the objects of the business logic that perform XML transformation. The use of technologies described above enables integration of any internet application (proprietary or non-proprietary) that could be used in the education process.

The four tier architecture described in this chapter was used in order to achieve better efficiency and scalability of the system. The verification process of the e-learning system showed that it can process approximately 100 requests per second.

## 2 E-CHO case studies

E-CHO system is used through several different courses at the Faculty of Electrical Engineering, University of Ljubljana. This target environment is specific as the faculty covers variety of electrical engineering fields, such as electronics, automatics, telecommunication or power engineering. Within different areas, students and teaching staff use different studying tools and didactical approaches that need to be integrated or embedded into an LMS. Therefore also various e-learning implementations for different departments have been prepared [19].

For example, students of the first year of the undergraduate study use E-CHO LMS within "Computer Engineering II" subject. Through the E-CHO system they can learn different programming languages and program using specially designed emulator. This course was successful, as the first year of undergraduate studies comprises around 300 students and the quality of the lecturing process increased with the introduction of E-CHO as a part of their studying process.

The second subject, where E-CHO became important part of education process, is "Fundamentals of Electrical Engineering I", where topics, covering electrical and magnetic fields with visual presentations, animations and interactive simulations, are included (see Figure 3). This content is used widely among undergraduate students, assisting them to conclude laboratory work and exercises compulsory to the subject.

E-CHO was introduced also for two modules (Process automation and Intelligent systems) of the fifth year at the Automatics regarding the subject Multivariable systems. It is used during the time of laboratory exercises, but it also enables testing and experimenting using virtual and remote experiment which mimic complex multivariable process control problem (see Figures 4 and 5) [20]. In Figure 4 the animation of the process is presented together with system responses, which illustrates basic system properties in time domain, while in Figure 5 the remote usage of the pilot plant is presents as can be observed through video stream.

Postgraduate students use E-CHO as the main studying tool within the "Project management and communication in research and development" course. This course consists of different invited lectures from professionals

**Figure 3**. Interactive "Fundamentals of Electrical Engineering I" course in the E-CHO LMS

in the corporate and academic sector from Slovenia and abroad. Some lectures and speakers change on the yearly basis. All previous lectures are available to students with-in the E-CHO system. Each lecture consists of synchronized video lecture with additional slides or other multimedia material used within the lecture. This forms a base of more than 40 different lectures for new students. As each of the students needs to prepare one project as the final result of the subject, communication and collaboration among peers and teachers was performed within the E-CHO system in order to achieve the goal. All projects were submitted through the E-CHO system and graded by the teacher. Each student needed to present the project live in front of an audience. Presentations were also re-corded in the same way as the lectures and inserted into the E-CHO system. This enabled students to see and improve their presentations as well as teacher to thoroughly grade their knowledge.

There were more than 2000 students enrolled in different e-learning implementations until now.

## 3 Conclusions

There is a rapid change in the concepts of software used for modern e-learning. Unlike the past, this change is not technology driven but by new ways of using modern technology, meaning communicating, collaborating, community building and generating content on behalf of end users. It is expected that e-learning software in the future, such as LMS and other systems used are going to become less and less content delivery systems but more and more content authoring tools, where content and learning is going to be created [21]. Systems used in e-learning will represent one of the nodes in the web network of content. These systems will not be applications installed and maintained by a target organization or company exclusively, but will become personal learning environments, a collection of interoperating systems, adapted to the learners' needs and interests. At the same time need for knowledge management in the corporate and academic environments increases. This calls for integration of additional structured and organized features into e-learning software used. Both tasks are contradictory and difficult to achieve. At the Faculty of Electrical Engineering we have developed an LMS named E-CHO that is used in different corporate and academic organizations. Through an iterative process of adapting our LMS we are trying to meet the objectives of the modern e-learning as well as to support the knowledge management in the target environment. However, there is a long way to achieve both tasks and many more implementations will have to be performed in the future in academic as well as corporate target environments.

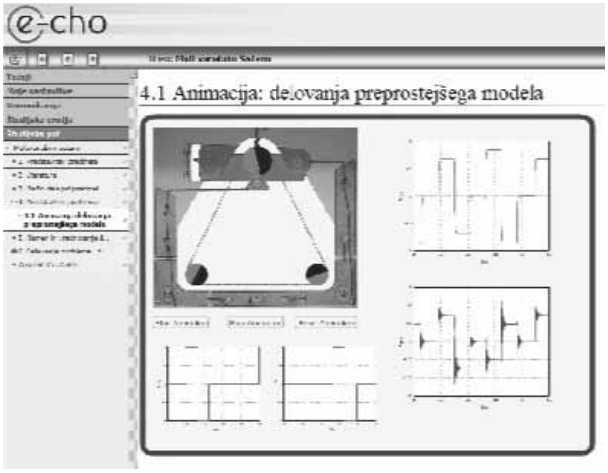


**Figure 4**. Virtual laboratory – animation of multivariable process

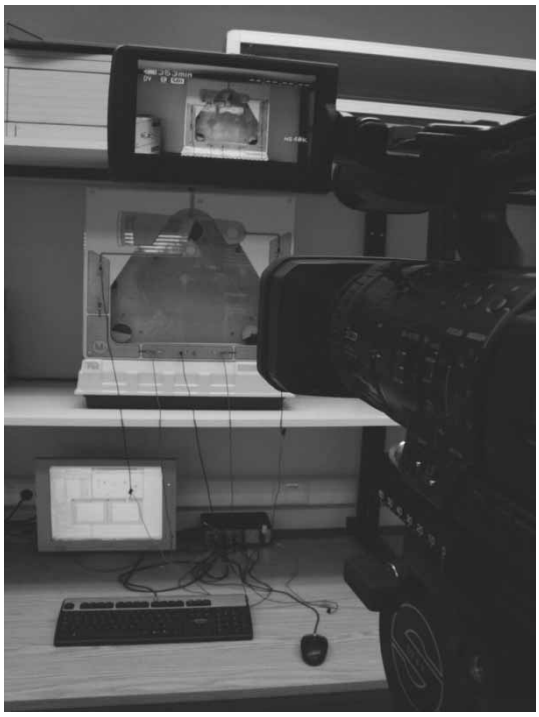

**Figure 5**. Remote usage of laboratory pilot plant

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