System Development for e-Learning in an Institution of Higher Education

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Better use of time, decreased educational costs, more effective learning and learning management from the user's side stimulate changes in the transmission of knowledge and learning. The Faculty of Organisation and Informatics (University of Zagreb, Croatia) was one of the places where a project for developing an e-learning system was started in accordance with user (student) demands and teaching process. Within this project, the production of a system for managing e-learning as well as adjusting teaching materials was started. This paper presents our achievements and results of using the developed e-learning management system in our institution.

Key words: e-learning, SCORM, LMS

Sistemski razvoj elektronskega učenja v visokošolski izobraževalni ustanovi

Boljša izraba časa, zniževanje stroškov izobraževanja, učinkovitejše učenje in učni management uporabnikov spodbujajo spremembe pri prenašanju znanja in učenja. Fakulteta za organizacijo in informatiko Univerze v Zagrebu (Hrvaška) je eden izmed krajev, kjer je, v soglasju z zahtevami uporabnikov (študentov) in z zahtevami učnega procesa, začel nastajati projekt razvoja sistema elektronskega učenja. V okviru tega projekta se je začela izgradnja upravljalskega sistema za elektronsko učenje kot tudi priprava učnih gradiv. Pričujoči prispevek ponazarja naše dosežke in rezultate uporabe razvitega upravljalskega sistema elektronskega učenja v naši ustanovi.

Ključne besede: SCORM, LMS

1 Introduction

According to Conole (2004) learning forms and models have been changing over time; on the one hand, adjusting and coordinating the needs of pupils-students for unhindered access to the flow of information and knowledge and, on the other hand, public-social and material possibilities for the realisation of such a transmission. Today distance learning (where a student is geographically dislocated from the place of a teacher or institution that is implementing this learning) is becoming more common and it is particularly supported and encouraged by information-communication technology (ICT), which also reveals new possibilities for learning with regards to material and techniques. Over the years, distance learning has been carried out in a few different ways. Miller (2004) distinguishes between four models: the correspondence study model, the tele-course model, open university model and distributed classroom model; similarly, the *US National Center for Education Statistics* (2000) list the generation of distance learning that is differentiated according to its material base (or means) by which it functions.

The influences ICT has on distance learning strategy are numerous, but, according to Miler (2004) they are estimated as positive, so the clear connection between the applied technology and user satisfaction can be established, as can be found in Chiu (2004). However, there are some specific disadvantages to such learning. Learning that is led (or helped) by the computer is deprived of (in a certain measure) social and public components. It is obvious that classical learning should be combined with ICT use, but there is a question in which way and how to choose applied modes of ICT use.

The last decade of the 20th century brought some few changes in learning organisations, and a special development appeared in the field of programme solutions, combining the programme and the technical possibilities of ICT (as presented in Cross (2005)), and specially the Internet (as we can see on Figure 1). A new form of learning, so called e-learning, is being introduced. The solutions for e-learning systems support combines computer networks, software toolkits, media for saving and transmis-

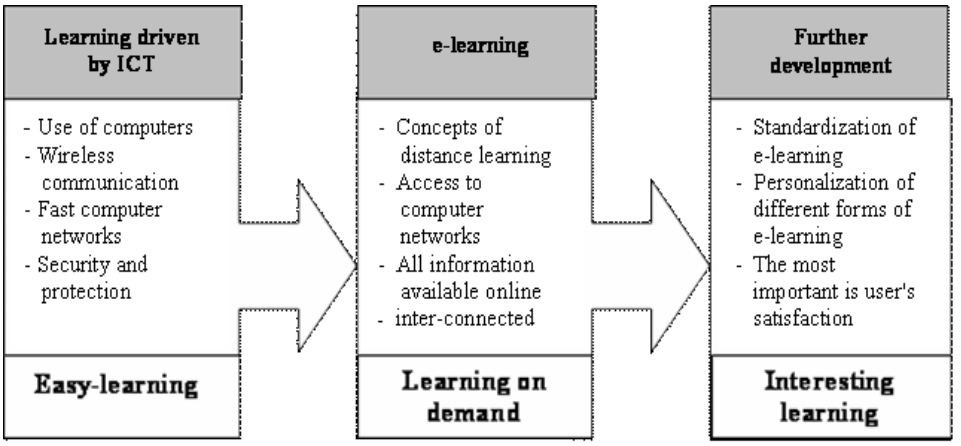

Figure 1: Development in the field of learning supported by ICT

sion, multimedia content and curriculum of the targeted audience. According to Conole (2002), numerous toolkits are used for supporting e-learning systems, either individually or as more complex LMS systems (*Learning Management System*), LCSM (*Learning Content Management System*) and other versions as has been stated in Ismail (2002) and Kaye (1991). Weller (2005). These authors also list some new e-learning process support possibilities as blogging, audio-conferences, "rotisserie" systems and instant messaging.

Aside from the kind of support that is being applied, e-learning is increasingly widespread, and what is particularly indicated is:

- a significant increase in the number of different tools and technologies for e-learning and companies developing them, and as well more content adapted for these systems,
- e-learning programmes are mostly developed by government institutions and big companies,
- in general, users have positive opinion about learning supported by ICT,
- it is not known if e-learning is of better quality compared to classical learning and
- introduction of e-learning requires high human, time and financial costs.

According to Cantoni (2004) many of the newly appearing virtual open universities are of differing quality (their comparison is shown by Kaye (1991).

We can say that e-learning redefines classical forms of learning, and modern learning should work as an integration of electronic and non-electronic components for the purpose of learning performance optimisation (Rosenberg 2001). Current efforts in distance learning development are directed towards standardising, personalising and promoting the quality and satisfaction of system users; the Commission of the EC (2003) stresses e-learning as one of the bases of development and connection of European society.

One of the results of the e-learning development plans is presented in this paper. In accordance with the need for learning process promotion and the transmission of knowledge, the Faculty of Organisation and Informatics started a project of e-learning system development. The desire was to support and promote classical forms of knowledge transmission by the use of ICT. In the structure of the project, we started the construction of a system for distance learning management and the adjustment on learning materials and the learning process itself. Three aims were set as:

1. to research what the promotion possibilities of classical forms of learning process performance by the use of ICT are, what the possibilities of implementing modern forms of learning are and which demands should be satisfied,
2. to form and build a system that will be a support and supplement to the classical form of learning, that will integrate the Internet and will be developed according to the users' (students') demands and
3. to research if the developed system satisfies and contributes to learning performance.

This paper is a report of an e-learning implementation project in the formal environment of an institution of higher education. Empirical data gathered during research does not have any intention of proving the condition, development directions or new methods in the field of e- learning, but to demonstrate how system development for e-learning in an institution of higher education occurred and what kind of model was used in this research.

2 E - learning Introduction Process

On the basis of ideas encountered in the problem area of distance learning, particularly e-learning, stated in the previous section and preliminary research published in Sajko (2005), an e-learning application project in educational process was started in the framework of one course. The following tasks were set by this project: to offer the possibility for unlimited learning in the terms of time and space and following teaching via the Internet, to make easier the administration of documenting evidence and

evaluation of students' knowledge, to make distribution and access to the teaching material easier and to provide transparent teaching. However, the task was not to create a system that would be a replacement of classical teaching.

Despite the fact that some of the given tasks were already filled with existing computer support and some of the organisation of teaching had been achieved (communication, distribution, unhindered approach), some of the following problems were observed:

1. communication services dispersion among numerous information services makes their use complicated and deters less experienced users
2. the scope of a learning process and the quantity of material as well as a higher number of directions made updating and managing the contents, which used to be available on-line, more difficult
3. opening off-site studies where a part of students do not have chance to attend classical teaching every day
4. students have become more interested in independent work and self-organised learning regardless of their location
5. more and more complex and long-term communication with students and their mutual communication have become topical exchange of information

This project was intended to gradually implement the system for e-learning management and support. It was decided that the original independent system formed according to users demands and needs would be developed concerning the specific qualities of the educational process, the sorts of content that are being realised as well as the conditions of the environment in which the system was to be implemented. Existing software solutions did not meet the needs of the institution. The new system was expected to achieve additional results with regards to better system understanding and knowledge as well as lecturers' and students' motivation.

The demands put in the face of e-learning system include:

1. the ability to transfer the existing digital content (learning materials, student marks and submitted material) to the new system (importing from standard MS Windows data)
2. the ability to form and manage the learning programs and seminars
3. the ability to follow the progress of users
4. the existence of specific forms of reports
5. the establishment of a hierarchy of users with defined authority for work on the system
6. support for the different communication forms between mentors and attendants
7. the ability to adjust system interfaces and postulates for each user
8. on-line learning performance control by users (self-guided learning)
9. the ability to search and examine the learning content
10. self-checking knowledge ability and examination of the attendants from the side of a mentor

This project signifies major changes in the field of learning process organisation, which implies the use of a particular style of learning and strategies of learning process performance; their implementation is described in more detail parting the rest of this paper.

2.1 Learning Process Organisation and Data Model

The dilemma that prompted the development of system also indicated how to organise the learning process. It implies the role of a lecturer in a learning process, the way of using ICT and their combining with the classical form of learning as well as the forms of learning content distribution. The experience and research of other authors, according to Rosenberg (2001), show that e-learning is the most effective in integration of class learning with e-learning architecture that includes the possibility for self-organised learning and training. Without any desire to exclude the classical form of learning performance, a combined approach was chosen as a basic strategy of teaching organisation. This combined approach integrates the existing forms; the learning process will be organised as a combination of teacher-led learning and independent learning.

Considering the results of some other researchers, the features of interactivity and participation in a learning process and the different learning styles and paradigms that can be applied, a strategy that implies the following postulates has been established (different learning styles and paradigms that can be applied are the subject of investigation in Hamid (2002) and Stankov (2005)):

1. the approach to the contents is of a closed type (authorisation on the system is necessary) with unlimited geographical approach
2. the learning materials are distributed primarily via the Internet (contents are set on the central computer), distribution is also possible by digital media (e.g. e-books on CD-ROM)
3. a part of the teaching is performed in a classical manner in classrooms and the rest virtually (distributed classroom model)
4. there is also a form of e-learning led by a lecturer (similar to classical learning) plus independent learning (organised as e-learning)
5. according to Cloete (2001), e-learning led by a lecturer is performed as synchronous learning, and independent learning as asynchronous learning
6. virtual classes are organised (on *LMS system*) and are identical to classes (groups) for lecturing and practice
7. class contents are available through the central database accessible via the Internet and the unique interface formed as LMS system
8. on-line seminars completely cover the syllabus and program of lectures and practice; they consist of number of lessons hierarchically organised into larger

Table 1: Qualities of a learning process determined by the project

OVERALL LEARNING PROCESS			
	e-learning		standard (classic) learning
	Lecturer driven	User driven	
Learning process is driven by	lecturer	user	lecturer
material availability	limited	unlimited	limited
level of formality	formal	informal	formal
using ICT-a	combined with classic learning	fully	possibility of using ICT
knowledge check	lecturer driven	self organized	lecturer driven
communication	verbal	different forms	verbal communication
progress monitoring	self-supporting	system-supporting	self-supporting

units, or so called seminars that are available through LMS system

9. learning is supported by the use of tools for support and help

Therefore, classical learning in classrooms will be combined with distance learning by the use of the Internet and e-learning toolkits, as we have summarized in Table 1.

Users have access to learning material, communication services and knowledge checks at any time while the teacher sets the tasks that follow the flow of the learning process, sets the deadlines for their mastery, keeps records and checks the acquired knowledge. The scheme of our developed LMS system is depicted in Figure 2.

The realisation of such a system involves the setting up four dimensions or components that can be considered as basic functional parts of the system:

1. learning contents
2. groups of system users and their authorities over the system (in the sense of communication and content management)
3. required communication forms among the users
4. ways of checking the results of users' knowledge

Data is one of the most important system components for e-learning as it presents content or information and knowledge used by students in the learning process. The division and organisation of the content into individual lessons has also been determined as well as its vertical connections into larger units. We have depicted the relationship between the four dimensions in Figure 3.

Considering there was a large quantity of digital contents that were already in use on the existing information services, part of it was directly transformed into SCORM compatible format. For faster transmission of such contents (mostly HTML documents), a toolkit for data import was used (*LRN Toolkit 3.0*) and during this process it was adjusted according to the SCORM standard. In that, Conole's (2004) five-step approach was

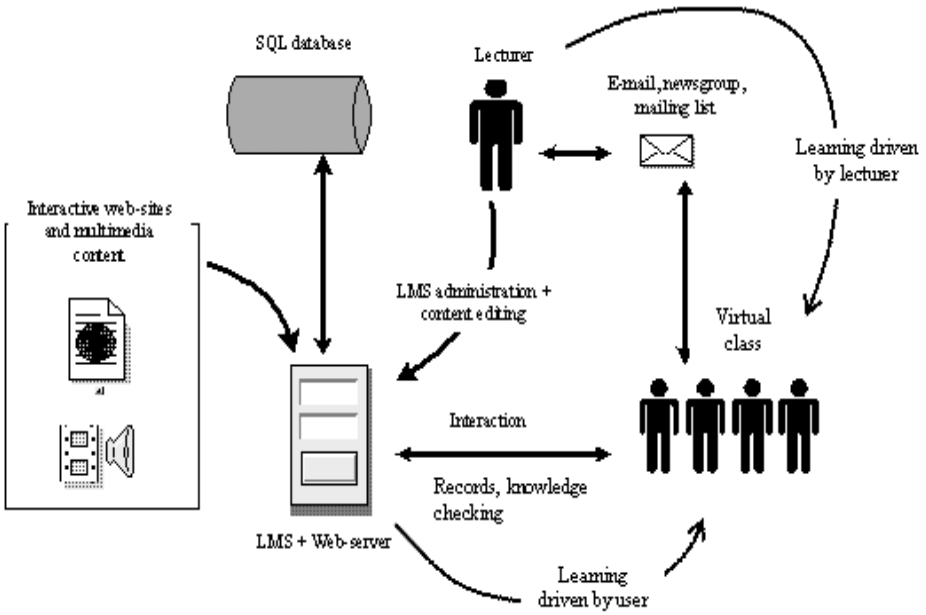

Figure 2: Learning process connections and relationships process scheme with the use of LMS systems

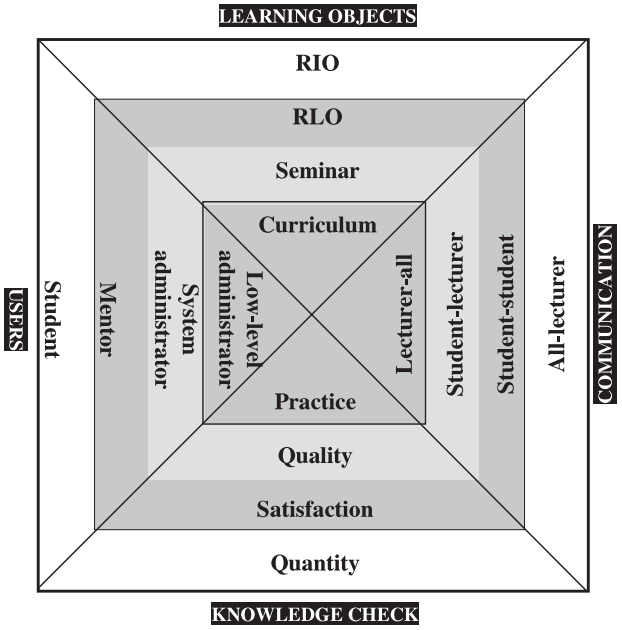

Figure 3: Key dimension hierarchy systems for e-learning

respected (check the existing course structure, analyse the course and identify the fields that can be better supported etc) for content reforming and restructuring.

For construction of the new learning material *MS Word, MS PowerPoint, Macromedia AuthorWare* etc. were used; static items used *MS Office* file formats, PDF file, html formats while the dynamic ones used *Flash, Macromedia Authorware*, DHTML etc.

The SCORM model was consistently applied to the contents. The lessons are hierarchically structured so that each one (a *Reusable Learning Object* – RLO) consists of set 7 ± 2 the smallest basic objects (*Reusable Information Object* – RIO) that are grouped together with the purpose of the user learning something. Lessons (RLO) are treated as the elementary knowledge units that contain the topics, examples and learning tasks elaborated in details as well as some references on the literature with even more detailed problem elaboration. One lesson is organised in such a way that a learner needs about 15-30 minutes to complete it. Considering the great number of existing and newly created learning objects, a hierarchy in which lower level objects enter the system of higher-level objects has been established (Figure 4). According to the SCORM model, more RLO objects make and teaching unit, more teaching units make a seminar, and more seminars make a programme (Curriculum). The content hierarchy is presented as follows (Figure 4):

1. Curriculum – teaching direction programme
2. Seminar – encircled topic unit from LEARNING programme
3. Lesson – responds to one lecture (RLO)
4. Topic – title within this lesson (RIO)

On the lowest level we have RIO object classes. Each RIO consists of three components (content, part for practice and part for assessment of newly gained knowledge). Next, similar to RLO objects, each RIO possesses metadata describing its structure (features, function, object…), purpose and (possible) connection(s) with other objects.

These metadata are e.g. RLO title, the field of a special interest, the name of the author, the date of creation, the date of publishing etc. Each RLO has its structure and title and should ensure the check of newly gained knowledge. In the structure it is determined which RIO object will enter the system of a RLO object. Data about the lesson (supplier, department, time when it is available, short description, method of payment, author of seminar, moving direction) and metadata are in the title.

The component part of the RLO definition was also significant for evaluation. The practice section offers the student a chance to apply the gained knowledge and skills. The testing contents were also formed respecting the SCORM standard, and their relationship with the learning objects is shown in Figure 5 (metadata within RIO object definition).

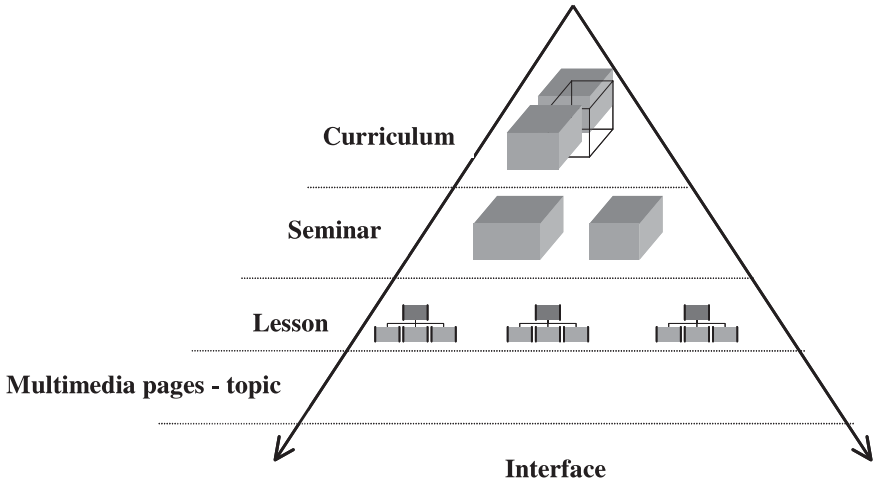

Figure 4: E-content hierarchy

```
< subject  name [metadata]>
< RLO name[metadata]>
< RLO content>
        < RIO1 name>
        < RIO2 name >

        <RIOn name>
<RIO1 name [metadata]>
        < RIO1 content >
                <content>
                <section for practice and assessment [metadata]>
< RIO2  name [metadata]>
        < RIO2 content>
                < content>
                < section for practice and assessment [metadata]>

< RIOn name [metadata]>
        <RIOn content>
                < content >
                < section for practice and assessment [metadata]>
```

Figure 5: Example of one lessons structure

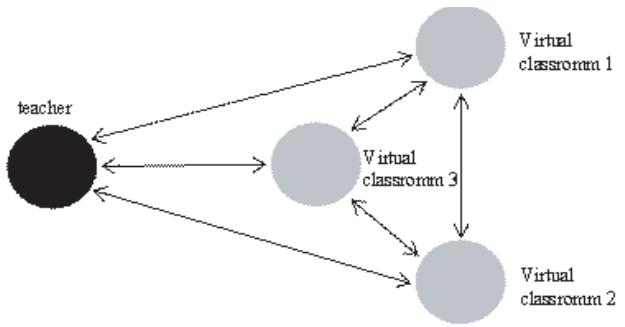

Figure 6: Connection and interaction ability among the participants in a learning process

Satisfying the needs for following the progress of users even on more levels, a knowledge checking hierarchy that enables following and registering of particular levels of students' success, was determined:

1. monitoring work quantity (date/time, number of user, number of successful readings)
2. monitoring knowledge quality (on-line tests)
3. monitoring satisfaction of users (survey)
4. self-checking of knowledge (practice, YES/NO tests, free answer tests, multiply choice test)

Finally, the communication dimension was used to define styles of learning (forms of synchronous and asynchronous learning) that users can choose themselves or are pre-determined; the way of interaction among the system users and programme logic ensures its realisation. There are some enabled forms of formal communication among all participants of the learning process in which a lecturer has the central role of a communication moderator and manager (Figure 6).

Furthermore, there is the possibility of informal communication among the students without the leading a lecturer. The user dimension has an established hierarchy and relationship among the users; their abilities, rights and duties in using the system have also been established. For the mentor's, services for learning contents and learning process organisation and management have been ensured, while for the students there are services for access to educational content and communication with a lecturer.

2.2 System Development Steps

As a base for developing the established model that could serve as a support for forming functional components, a software programme developed by a company-partner on the ITC project from Zagreb was used. ITC "*eLearner*" is based on ADL's (A*dvanced Distributed Learning Initiative*) *Sharable Content Object Reference Model* - SCORM concept defining two basic functional system components for e-learning, as can be found in Robson (2001):

1. *Learning Management System* (LMS) – implies delivery and enhanced concept or, in other words, it means delivering learning materials directly to the user and learning improvement
2. *Learning Object* – IEEE (2004) and Wiley (2000) defines *Learning Object* as any type of entity that can be repeatedly referenced during the learning process supported by technology any other digital resource that can be used (repeatedly) in a learning process

ITC's "*eLearner*" belongs to the group of *Learning Content Management Systems* (LCMS) (which are well described in Ismail (2002) and Stankov (2005)) that ensures an environment for development and maintaining learning content. This programme was in the development stage, and its working version supported functional abilities that we can find in similar systems: entering a system, adjustment to interface postulates, data organisation and management, updating and creating programme and

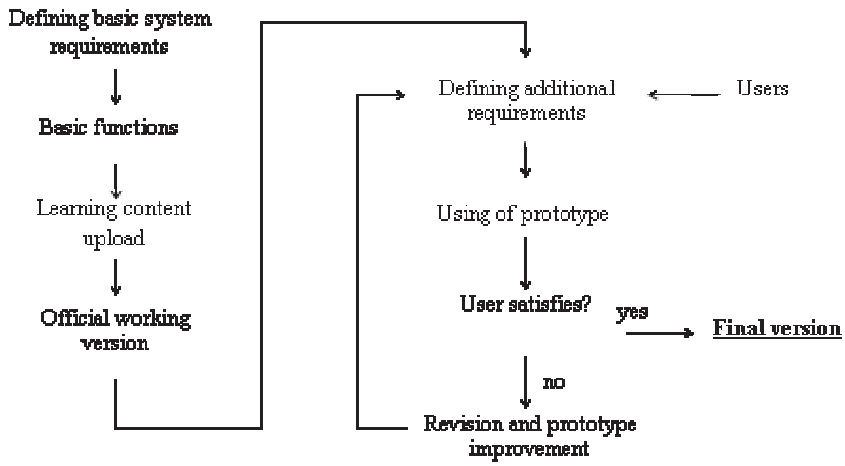

Figure 7: Stages of the project implementation

communication services among the users. However, ITC's "*eLearner*" also included the use of communication services and the Internet. Their beginning version was presented in such a way that ensured technological support to the further development and adjustment to the needs of a learning process on the Faculty. Further efforts that were supposed to be taken were directed to the forming of the demands defined through four-dimensional model (Figure 3) that would enable the lecturer-mentor to compose, organise, and mange the learning contents into hierarchical and meaningful units as well as interaction with students. Ismail (2002) called this part of the system for e-learning the *Learning Support System.* It enables wider support for e-learning and includes toolkits for:

- students group (classes) management,
- creation and organisation of programmes (courses),
- tracking system use,
- delivering material for different communication toolkits (discussion, synchronous messaging, whiteboards etc.)

Additionally, the system was supposed to satisfy some other desirable features or quality factors in on-line learning (quality factors are investigated in Alley (2001)) or system elements for e-learning including design (system elements are the subject of investigation in Hamid (2002)).

When discussing system development, its gradual adjustment and introduction in teaching were planned and a particular programme version was checked and completed in steps. This model of prototype development resembles the combined top-bottom/bottom up approach described by Cloete (2001). In our case, in the first stage only the top-bottom approach was used and the stage was finished with a functional system in the working version. In the second development stage, the bottom/up approach was continued, and repeated in more iterations until the system could satisfy the ultimate user, as is shown in Figure 7.

The examination was done with all three predicted levels of users (administrators, mentors and users/students) and it included:

1. checking the validity of all system functions (management, entry, review, communication, observation, work analysis, navigation through the system, content organisation, statistics etc.)
2. checking working system possibilities under burdens (classes and teaching) similar to the usual ones
3. checking how the system supports e-learning (work in a typical teaching period, teaching material interpretation, checking the learned material, discussion)
4. evaluating the system's total quality and possibility
5. evaluating the user's satisfaction with the built system

System behaviour and satisfying the functional abilities from the users' side were tested by two groups of students, 15 in each group (voluntarily registered). Although such burdens are minimal compared to the expected one,

Table 2: Examination of participants according to the stages

Participants	Session 1	Session 2	Session 3	Session 4
	Functional properties	Functional properti ; and classroom support	Classroom support	Functional properties and classroom support
Administrator	×			×
Mentor	×	×	×	×
Students – 1. group		×	×	
Students – 2. group				×

it primary task was to examine if the system could satisfy functional demands. The first group participated in the second stage of testing, and in the third one after which the correction of mistakes in the system work was done and upgrading of some new demands followed. Table 2 displays the results:

Student evaluation of the demands was informal, but before the final one there was a brainstorming session where the participants discussed ways of improving the system. Evaluation and further analysis of the best proposals were brought. The second learning process simulation was done with the second group of students in the last examining stage in which the remaining groups of users (administrators and mentors) participated. The milestones and stages of the project are presented in Figure 8.

During the examination, a few mistakes and demands for upgrading were established, but they were corrected before the final issue:

1. for administrators
   – simpler adding of lessons and seminars which is rather time demanding as important content quantity was predicted
   – organisation of lectures, seminars and courses
2. for mentors
   – detailed tracking of each student's progress and keeping statistical records on their work
   – total time on seminar, final percentages of seminars
   – access to each separate unit, time spent on each unit
   – ability to manage the communication of users
3. for all
   – concentration of all services inside one system
   – two-sided communication among all users
4. for users

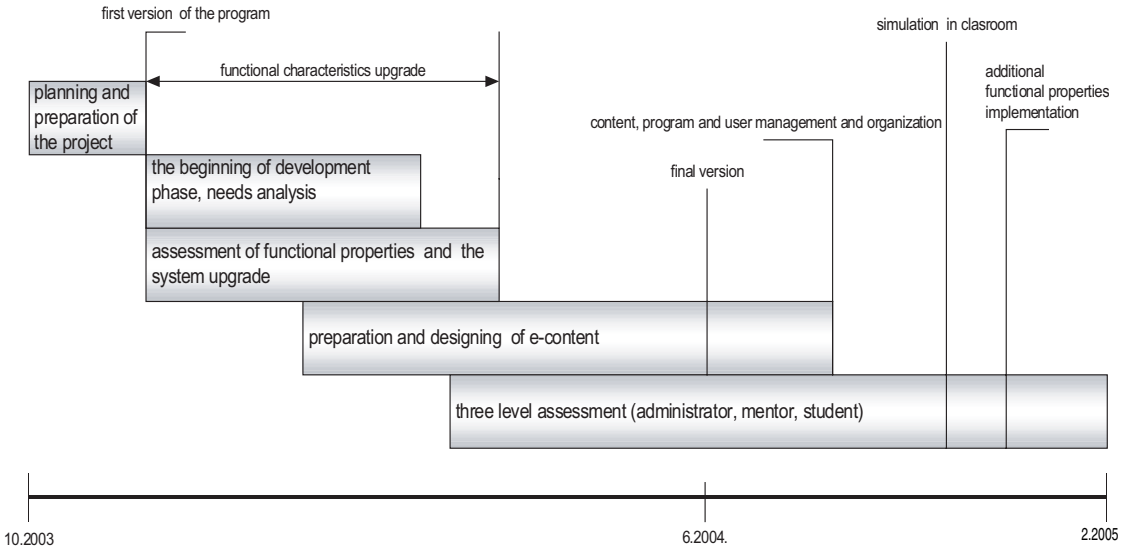

Figure 8: Milestones of the project implementation

– separate communication environments for each group (class) and each seminar
– private communication (messages)
– ability for on-line knowledge check for each lesson

3 Final Examination of System Quality

After the first iteration of functional abilities examination, the system was released experimentally. What followed was evaluation by the users (mentors and students) through some informal conversations and discussions. Formal examination of users' satisfaction was implemented after four-months of experimental work with the final version of the system. In total, there were 103 students who participated in the final examination by web-survey (voluntary access to the examination) of the first study year.

It is important to stress their experience in working with similar systems, as simplicity was one of the most important tasks in the system formation. According to their own assessment, the questioned students are inexperienced in working with similar systems and most of them used them for the first time. From the total number of the questioned population, 78% did not have any working experience with LMS systems, and 71% encountered them for the first time. Only 4 % of the questioned said that they have considerable experience in working with LMS systems. Therefore, we can conclude that the sample satisfied the criteria "*inexperience with the e-learning system implementation*". The groups of questions by which the quality of the system was assessed are:

1. the user's satisfaction with the system,
2. the frequency of the system use and
3. user's opinion whether the system helps in teaching

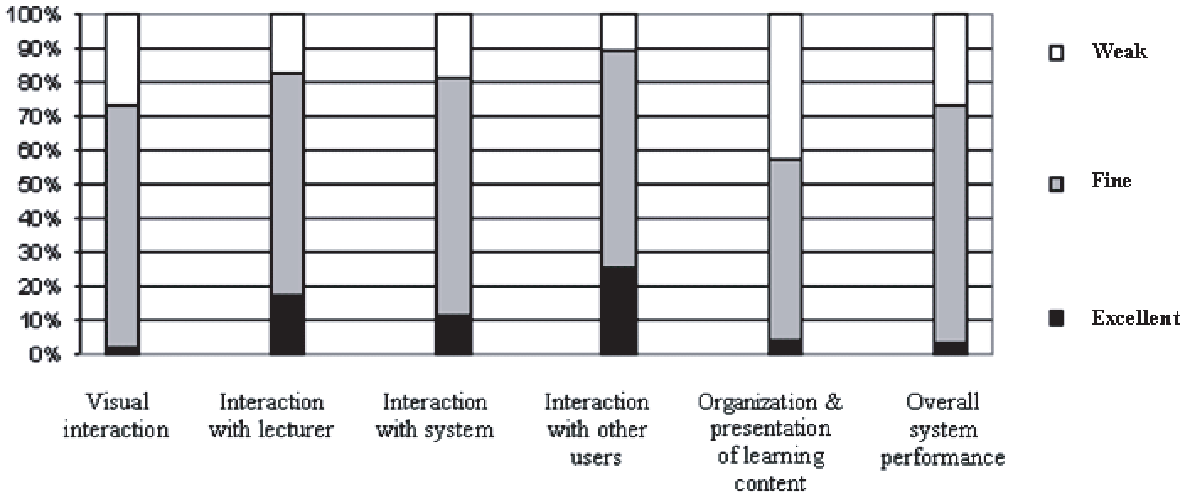

Figure 9: Respondents' satisfaction with the e-learning system features

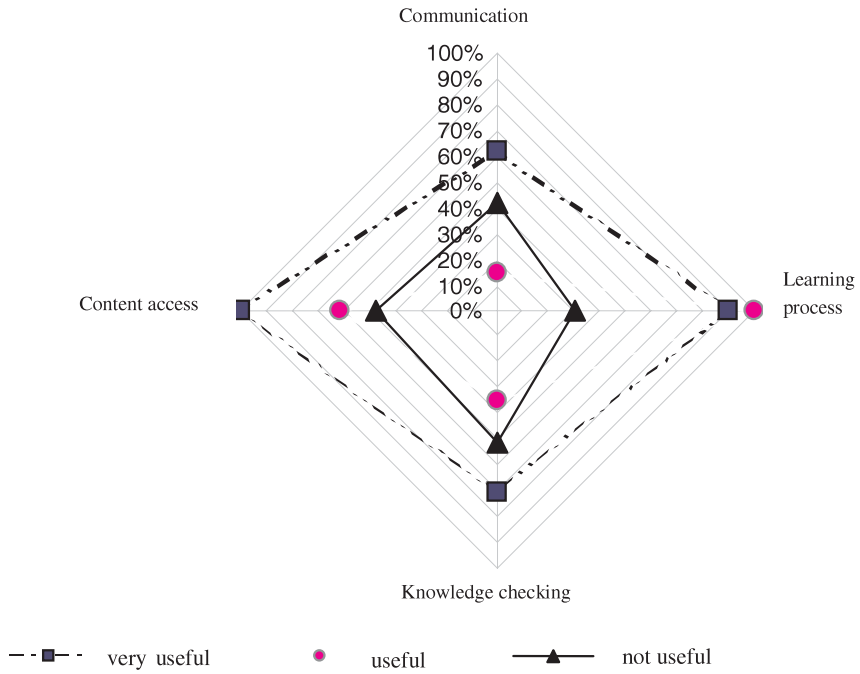

Figure 10: System use and assessment of its usefulness

According to the results shown in Figure 9, the respondents are mostly assessed the system positively; the best assessment is given to the appearance and to the total abilities of the system. What is particularly satisfying is that the system complexity assessment as 76 % of the respondents said the system was simple to use, and for 24% it was moderately complex.

The system functionality assessment and the ability for its use in learning are shown by the results in Figure 9. Therefore, we can see that the system can be widely used in the learning process. Almost all the users during teaching performance and independent learning were using the system for accessing content (100%) and in learning (90%). Slightly less implemented were system communication abilities (62%) and self-knowledge checks (71%).

It is interesting to consider the results showing how these features have helped to students in their work. They unanimously assessed that this system helped them in learning, but that some of its particular features had not completely satisfied their expectations. We can conclude that the project has brought some positive results, however further development of system's functional abilities is important.

Finally, through this survey, there was left a possibility for free commenting on the system quality. The collective results of these comments can be found in Table 3. In that, the formed The e-learning system was confirmed as

Table 3: Students' comments can be summarized as follows

Good sides	*System is simple, interesting and easy to use 37%*
	Content is well presented and quality of content is good 30%
	Content is easily accessible 25%
	System is practical and very applicable for learning purposes 8%
Bad sides	*Nothing 51%*
	System is instable and slow 23%
	System is not available to everybody 12%
	System's interface and the way it is used could be better 8%
	Communication abilities are low 6%

simple, and reviewed as an interesting learning toolkit that can make the access to treated contents easier in the terms of quality.

Instability and slowness were highlighted as the biggest disadvantages of the system; the technical base of the system will have to be improved in time. Quality judgment (specially self-guided learning) is limited by the fact that 30% of students have inadequate access to the Internet. This is stated as a reason that some students are thought to be deprived by such way of learning.

4 Conclusion

The adjustment of the existing supplying materials for e-learning system has been successfully implemented. The system was also examined and implemented in a teaching process that made concentration of different abilities possible:

1. combined teaching organisation in a classical way with a leader plus distributive classroom (leader and self-guided)
2. unlimited space content distribution and all-time access to learning contents
3. ability to follow and register students' work and check their knowledge
4. different forms of communication and management among the users
5. ability to organise and manage different study programmes

It was shown that the system is useful for preparing the students for teaching, as a reminder of the learning material, as a means to give practical tasks in digital form and gathering solution and on-line tests realisation. Except for the communication forms (face to face during teaching, consultations, via e-mail or news group) that were already available, through the use of additional computer networks, "ITC eLearner" enables the electronic communication among students group, thematic Internet chats in real time, thematically-led forums tied to virtual classes or particular seminars and a message system similar to e-mail. The advantage is also that all communication services are integrated within one system, which makes finding the interlocutor easier. Concerning the advantages for lecturers, the evidence and organisation of teaching is much easier as well as following teaching activities and activities of particular students and formalising learning contents.

A negative part of the results is determined by technical condition of computer-server work for e-learning. The examinations showed that the system, when working with 30 users, does not have satisfying performance, which we ascribe to a weak hardware system base.

Very interesting, but requiring a longer period of monitoring and investigation, are the changes in teacher-student relations, and the student's relationship to the learning process in which the attendant will no longer be a passive listener but also a leader of his own education. In this plan, a new aspect of communication between mentor and students or students among themselves is expected.

Our experience in the system used in teaching shows that interest for e-learning is directly conditioned by the interest in ICT; those users who are inclined to ICT can experience a saturation of learning that is deprived of interaction with people. It is obvious that the learning process and knowledge transmission is much more complex than just presenting facts. Learning with machine support is undoubtedly asocial and excludes defined human needs. However, e-learning system and distance learning as a form of knowledge transmission will develop further and specially in the direction of individual learning. Satisfaction criteria of the students will be a decisive success measure. Examination of the quality and users' satisfaction shown in this paper gives reason for being optimistic and continuing with using such systems. Learning and the form of its realisation will further follow the technological trends so we can expect the further increase of such applications and some new forms of their implementation, but for now the technology does not have power for replacing classroom learning.

In the "deluge" of such approaches, this is one of the possible ways in which the institutions can build their own system. The presentation of developing the system by the method of a prototype based on the users demands and SCORM concept implementation represents a contribution to the future efforts to promote the learning process by ICT use.

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