

Development of a Learning Content Management System

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Abstract: - Change appears to be the only constant in the field of ICT and what was treated as advanced feature few years ago is today old-fashioned. If dealing with such rapid change in the field is increasingly difficult and complex, it is even more complicated when one tries to simplify the concepts and processes and define the learning system's model and the features that would contribute to a more effective teaching and learning. As part of the research project team, which aims to develop software for Learning Content Management System at SEE University, we primarily had to select the features that would cover our needs and also comply with the actual trends in this area of software development, and then design and develop the system. In this paper we present the in house development of an LCMS for South East European University, its architecture, conception and strengths.

Key-Words: - e-learning, LCMS, e-learning systems, conceptual design, architecture, system modules

1 Introduction

As a result of the rapid development of the information and communication technologies and their increasing relevance in all aspects of our living, the role of e-learning systems increases too. E-learning systems build up a platform for the realization of new study forms (especially the distance mode). The success of this platform depends on its involving into the integrated solution of the information systems at universities. E-learning system is a complex, data system primarily determined for the support of the pure set of e-learning activities. These activities include not only study activities, but also managing activities and governing of study courses. Generally, it means the integration of kind of systems as Learning Content Management Systems (LCMS), virtual learning environment (VLE) or communication portals into one complex system. But, there is a dilemma. All kinds of these systems are usually distributed by various producers and the integration cannot be performed on the maximum. Students are faced with the situation where they must use few practically independent separated systems and make endless authorizations, uploads or imports. These can be eliminated only by the purchase of the complex system or the development of the own system. By this the flexibility and the integration of all parts can be achieved.

“A LCMS is an environment where developers can create, store, reuse, manage and deliver learning content from a central object repository, usually a database. LCMSs generally work with content that is based on a learning object model” [17]. The in-house development of these systems is not typical approach in building environment for using information and communication technologies for the support of the educational process. But on the other hand, there are some institutions which have selected in-house way and have accomplished its applicability. One of them is South East European University, Macedonia.

2 E-learning systems at SEE-University

Information and communication technologies (ICT) are a mainstream issue in higher education. Within higher education, there is evidence of constant innovation and changing approaches to provision of online services. It is now an accepted practice to integrate ICT in major logistical, organizational and educational processes of the institution. In this part we present the experience in building up and applying e-learning at our university starting from zero till the development of the LCMS that is the objective of this paper.

South East European University is a new private university in Tetovo, Macedonia, created seven years ago by foreign donors and managed by foreign and local managers. As such, it was fortunate enough to be transformed into a university with hallmarks of a modern university, incorporating new ways of teaching, a flexible use of languages, a smaller size of student classes etc. In such an environment, one of undisputed objectives was also setting a sophisticated system of e-learning.

At the very beginning a campus intranet networking was set up, with an open access for all campus inhabitants to this network, 5 MB for each student and 70 MB for each staff member. The objective behind setting up this ICT infrastructure was to provide a foundation for a system where e-learning and ICT would have a prominent role [13]. In modern universities, where the IT fluency of the students is usually high and computer use is standard, the ICT strategy would focus on using ICT in lectures and studying. This can be difficult in transitional countries, where the number of people with access to computers can be relatively low, and comfortable access to Internet can be even scarcer. Therefore, in addition to providing PC/Internet access to everyone, one of the foremost objectives of the university was (compulsory) IT education for all students, and an opportunity for IT education for all of the staff. Aiming at building a standardized training system, a Computer Center was eventually created, and it now exists as a unit on its own of the university.

Part of the intranet memory that was for public use -the public domain contained folders for each course and housed electronic copies of the learning materials for each course. Weekly homework tasks were also placed in this folder, allowing students to access them whenever they want (naturally, respecting the deadline), even when they are outside classes. Homeworks were also delivered electronically – to this end, students used folders without read capability, that is, with write-only rights. Exams were also fully electronic - a web-based application that allows on-line testing of their knowledge.

In this period among others, a significant experience was achieved among the staff and students in preparing electronic form of teaching materials which was crucial element for the following steps in improving of e-learning at our university.

Latter on, the Learning Content Management Systems have become an important feature of electronic service delivery within the higher

education information services sector, demanding close attention to issues of functionality.

To ensure a quality education, while retaining the leading role in the country and the region as a whole, SEEU, at the beginning of the Autumn Semester 2005, introduced and implemented the usage of a new online course management software called ANGEL through the Instructional Support Center. SEEU is the first institution in Macedonia and the Balkan region that has invested in developing and introducing an online environment for learning and teaching through the application of this kind of software

Although there is usually an adjustment period for most students and professors, as they learn the rhythm and patterns of online communication, the interest for using ANGEL has grown from year to year. As it is shown in Fig. 1, till now there were added around 1100 courses in ANGEL, and the current number of users is 7700.

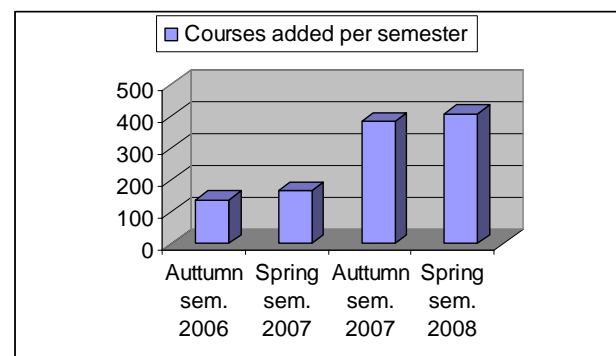


Fig.1: Number of courses taught using ANGEL in the past semesters.

The entrances of ANGEL, transformed completely the SEEU course management system in terms of teaching and learning, developing rich situations for collaborative knowledge construction, and information seeking and sharing. Being aware of the benefits of the usage of an LCMS and facing the expenses that were very high we decided to develop our own software.

The opportunity of Open Source LCMS was also considered, but because of number of e-systems like: e-roster, e-grading etc., that were implemented in our university during this period, we decided to design and develop our own system which would solve the LCMS issue but at the same time would offer a solid background for integrating all e-systems.

As part of the research project team, which aims to develop software for Learning Content Management System at SEE University, we

primarily had to select the features that would cover our needs and also comply with the actual trends in this area of software development. While analyzing and choosing the essential features of the software, we studied and analyzed several research papers that assess and/or, compare different LCMSs or simply indicate the main aspects when developing an LCMS. Next, we designed a LCMS for our university, where we implemented the experience from the research done.

3 Evaluating methods used in revised papers

As we went through the research papers that compare and evaluate the LCMSs, we noticed that in many papers, only a few aspects are studied. They might be important from certain point of few but they can not be decisive in defining the complete scheme of the LCMS. And on the other side there were some papers who considered almost every possible aspect of LCMSs.

In general, in different papers variety of criteria were considered and the complete research was very helpful in building standards for the right framework, methods and evaluation of the system. In this section we present some of the methods and frameworks that authors considered important

while evaluating LCMSs. Most of these frameworks are based on the frameworks for evaluating computer software and were adopted to meet the LCMS needs [3],[7],[9].

In order to make a distinction between different methods of evaluation virtual learning environments (VLE), in 2003, a simple framework was proposed by Dixon and Baretto [6].

The proposed framework consists of :

- the purpose of evaluation,
- type of evaluating methods,
- applied measures.

It also recommends various evaluation types (summative, formative, integrative), experiments used in evaluation process (case study or test study) and criterion to measure efficiency and usability of VLE. method

Another proposal “Framework for pedagogical evaluation of VLE”, comes in 2004, from Britain and Liber [3].

Their framework consists of two models that can be applied while evaluating LCMSs.

- The first model is the Conversation Framework which considers several ways of teaching (adaptive, discursive, interactive, and reflective) [14].

| Main groups of comparisons | Comparative criteria | Year of paper's publication | | | | | | | | | | | | | | | | | | | | | |
|-------------------------------------|------------------------------------|-----------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | | 1998 | 1999 | 2000 | 2001 | 2001 | 2001 | 2001 | 2002 | 2002 | 2002 | 2003 | 2003 | 2003 | 2003 | 2004 | 2004 | 2004 | 2005 | 2005 | 2006 | 2006 | 2006 |
| Instructional competence | communication tools | | | | | | | | | | | | | | | | | | | | | | |
| | file sharing | | | | | | | | | | | | | | | | | | | | | | |
| | activity support | | | | | | | | | | | | | | | | | | | | | | |
| | guided learning | | | | | | | | | | | | | | | | | | | | | | |
| Ease of use | multilingual support | | | | | | | | | | | | | | | | | | | | | | |
| | adaptability | | | | | | | | | | | | | | | | | | | | | | |
| Dynamic Delivery Interface | user tracking | | | | | | | | | | | | | | | | | | | | | | |
| | links to related sources | | | | | | | | | | | | | | | | | | | | | | |
| | multiple asses, with user feedback | | | | | | | | | | | | | | | | | | | | | | |
| | customizable interface | | | | | | | | | | | | | | | | | | | | | | |
| Administrative tools | monitoring usage | | | | | | | | | | | | | | | | | | | | | | |
| | course catalogs | | | | | | | | | | | | | | | | | | | | | | |
| | student management | | | | | | | | | | | | | | | | | | | | | | |
| | course management | | | | | | | | | | | | | | | | | | | | | | |
| Technical characteristics | feedback mechanisms | | | | | | | | | | | | | | | | | | | | | | |
| | modularity, extensibility | | | | | | | | | | | | | | | | | | | | | | |
| | optimization of features | | | | | | | | | | | | | | | | | | | | | | |
| | security, stability | | | | | | | | | | | | | | | | | | | | | | |
| | portability | | | | | | | | | | | | | | | | | | | | | | |
| | support (sts, admin.) | | | | | | | | | | | | | | | | | | | | | | |
| compactibility and interoperability | | | | | | | | | | | | | | | | | | | | | | | |
| integration | | | | | | | | | | | | | | | | | | | | | | | |

Table 1. Comparative criteria groups and evaluated features.

- The second one, Viable System Model, includes collaborative learning, considering resource negotiation, coordination, monitoring, individualization, self organization, and adaptation.

For both models, several criteria were proposed. We can determine if the LCMSs meets the proposed criteria, through subjective methods, like filling in questioners or elaborating comparison grids.

All the mentioned frameworks and methods were used in evaluating LCMSs. They cover certain areas and author's opinion about them..

Many of studied papers offered only a plain subjective method in which criteria were selected according to author's estimation (features usability, student centered approach, learning tools based approach, etc.).

4 Comparison scheme

In this study we compared more than 20 comparative studies and evaluations of LCMSs, published in the last decade and attempt to conclude if there are some indicators on the comparative aspects and criteria that would explain the current development state of an LCMS.

The comparative studies of LCMS, that actually were the object of our research, were chosen based on their availability on the web and their importance (citations). In our research we also included papers about evaluating open source LCMSs [4],[5].

We went over the main points of each comparative study and presented the results in the Table1 [1]. As shown in Table 1. we divided the evaluation criteria in 6 major groups: content, communication, environment, educational tools, management tools, and technical characteristics. Each group had more than a few criteria and many criteria were tied together (e.g. forum, instant messaging, chat and email support were joined into communication group).

The Table 1 header contains the analyzed papers sorted by year of publication while the first column contains the comparison criteria. If a certain criterion was included in the analyzed paper, the appropriate field is marked. During this study, we were aware that papers are published at least one year later than the actual time when the comparison took place, but we consider that this won't have any impact in the overall picture of LCMS development.

The research done on comparison and evaluation of LCMSs, lead us to the following conclusions [1].

In earlier evaluations, authors used criteria and features that were not present in later evaluations like integration of CD material and on-line content, batch student and courses input, application sharing and search possibility. Some of these features were substituted with other ones. Actually LCMS integration with other systems like registration information system, student information system, roster and other applications that contain data about students and courses replaced the need for manually inserting students and courses into an LCMS. In present research very often new trendy features are evaluated [15]. Some of them are blogs, social networking, and discussion forums. The impression is that social phenomena are very smoothly adopted in education and arranged to educational needs.

Adaptation is also a new feature that is considered in the later research, and it was not present in the past [11].

Generally, it seems that most of the features that were considered as important and significant in the past are part of the default features in current LCMSs. If this tendency will continue, probably new features will be added to support teaching and learning, and the system designers must plan the possibility of upgrading the system with new features.

Once we have analyzed and studied the current demands and the key features in the area of LCMS, we continued with the development phases.

In the next part we present the experience in developing a LCMS using modular approach, architecture and conceptual design, modules, implementing procedure and the strengths of our LCMS.

5 LCMS Conceptual Design and Architecture

5.1 Conceptual Design

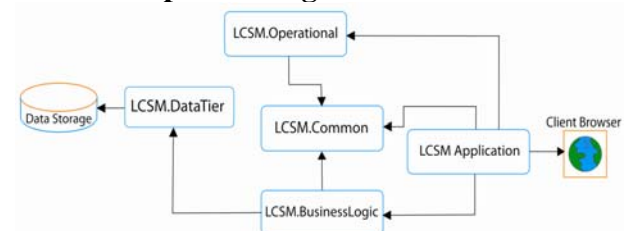


Fig.2: LCMS's conceptual design

An overview of principal components of the LCMS application modular architecture is given in Fig.2. The implementation is split into different parts:

- LCMS.Common –used for defining application entities (ex. Users, Courses, Resources etc.);
- LCMS.Operational –used from application for mail operations;
- LCMS.BusinessLogic –is responsible for all actions that are going on behind the scene;
- LCMS.DataTier –is used from LCMS's BusinessLogic for extracting and storing data;

5.2 LCMS's Architecture

In this section is described the architecture of the application. Today's most web-based applications use three-tier client/server model [8]. This approach clearly divides the presentation layer from content and data storage. This kind of system decomposition enables us develop large-scale software systems and reduce overall development time [16].

Using this approach, the application's architecture would be like in Fig.3. To present system's architecture, components diagrams are used. The following diagram is composed of three sub-systems: Web Presentation subsystem, Business Logic subsystem, and MySql database as data storage.

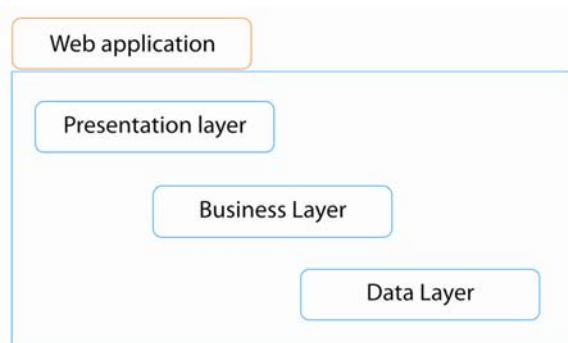


Fig.3: The LCMS's architecture

6 Implementing Experience

International Data Corporation, a premier global market intelligence and advisory firm in the IT and telecommunication industries defines Learning Content Management System as a system that is used to create, store, assemble, and deliver personalized e-learning content in the form of learning objects. However, not all LCMSs are the same. Providers of these systems differentiate their offerings via unique features and functions, the ease with which they integrate with other systems, and the degree to which they customize their offerings for an enterprise's needs.

Despite their differences, they do share the components depicted in Fig. 4. [12].

6.1 Components

In the next section we will present the above mentioned key components of an LCMS from the perspective of our university.

Our academic institution is working hard to make better use of our network infrastructure and existing databases to efficiently and effectively achieve learning and professional development goals by making some of the learning resources available to educators and students through learning object repositories by implementing them on a Learning Content Management System with an easy to use web-based graphical user interface (GUI).

6.1.1 Learning Object Repository

The learning object repository is a central database where learning content is stored and managed. From this point individual learning objects are either dispensed to users individually or used as components to assemble larger learning modules or full courses, depending on individual learning needs.

The management of the Learning Object Repository (LOR) is crucial for a successful LCMS. The LOR is fed with information from two sources: the University Management System (UMS) Database and the faculty (users).

1. The University Management System (UMS) Database is the central database that contains all the information regarding the faculty, staff and most important ones, the students. Data contained here is highly secure.

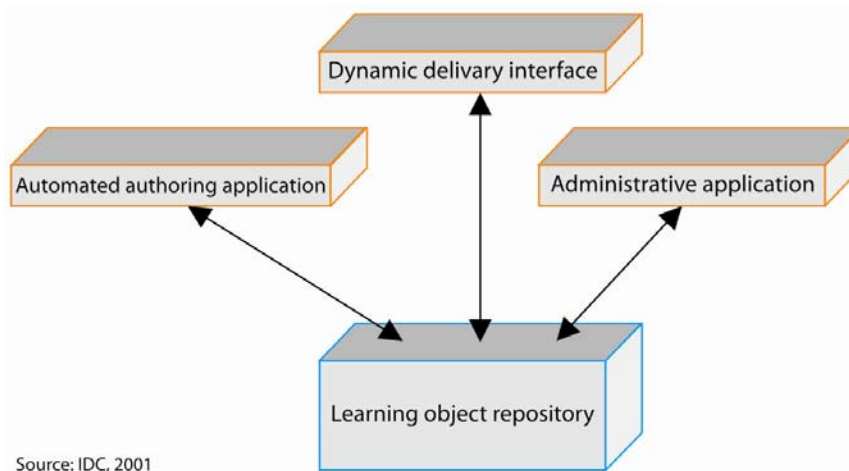


Fig.4: Components of a LCMS

The mainframe is placed behind a CISCO router that separates this mainframe from other servers and networks inside the University campus. Additionally there is a firewall that blocks any communication outside the local network. Data from this mainframe are replicated to another backup server where can be used by various applications.

For the needs of the LCMS this is done using another PROXY server (Fig. 5), which has direct access to the replica database and is distributing these data by web services which are secured as well.

2. The Faculty (users) are the ones that are creating the learning content. They can use an easy to use interface to upload their digital content of any form. This content is:

- stored in a file format and some in a database
- stored on an extensible hard drive and as such the storage issue cannot be considered as problem
- This content (resource) can be easily shared all over the application. This content is managed by an automated authoring application.
- The content can be moved and copied without any complication, and it is important to mention that any change on the hardware or software architecture in the future will not affect the LOR since it is based on file system.

6.1.2 Automated Authoring Application

The automated authoring application gives the users a web-based GUI that allows them to easily interact with the system and create content for their course.

By using a template alike form, users are able to create the desired content without having any programming or database skills.

The resources that are to be uploaded or created can be of various types, such as: documents, spreadsheets, presentations, electronic books, quizzes, announcements, messages and similar. Any created resource can be shared between users or courses without having to copy the resource multiple times. Sharing is done using globally unique identifiers (GUID), which helps in reducing the needed storage.

6.1.3 Dynamic Delivery Interface

Dynamic delivery interface is required to serve up a learning object based on learner profiles, pretests, and/or user queries.

The dynamic delivery interface changes depending on the users profile and access levels. This component provides user tracking, dynamic links to courses that users are enrolled to for a given study term, access to learning content, access to a personal calendar and messages. The content is presented on Web pages with a look and feel designed to reflect the University image. This interface is easy to use interface based on Asynchronous JavaScript and XML (AJAX) technology which gives the feeling of a desktop application rather than a web application [10].

This interface is based on ExtJS Framework.

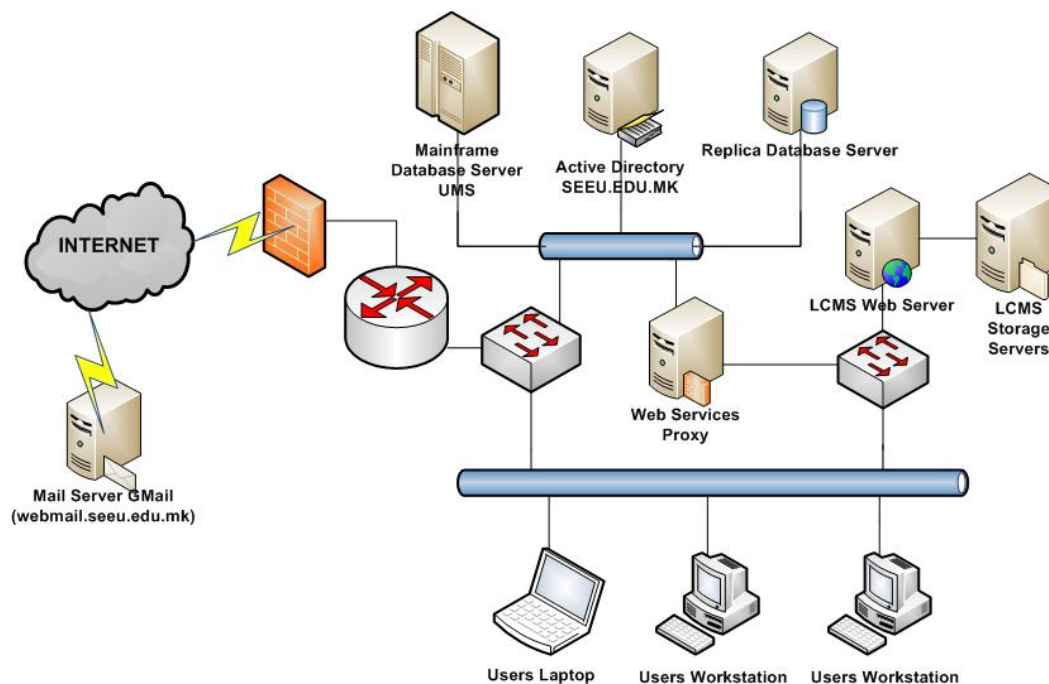


Fig. 5: SEE University Network Infrastructure

Using this technology has advantage over regular websites because the system never delay and the users' content is shown fast enough.

6.1.4 Administrative Application

The administrative application is divided in several parts.

First, the management of student records, student enrollment, course inventory and study programs are done by a separate system where the date is integrated into the new LCMS. If necessary, the administrators can manage user enrollment manually.

Next, the user management is handled by the Active Directory where the profile is stored as well. Finally the content for e-learning courses is managed by users depending on their access control or user level. For instance, teachers are able to add content, create tests and create announcements, whereas students are able to submit assignments, submit tests, read various content and similar.

Most of the administrative part functions automatically, since data is consumed from web services.

7 LCMS security

LCMS security is divided into two separate systems: User Access Control and Data Access Control.

7.1. User Access Control

User Access Control is handled by the LDAP (Active Directory) and the database Access Control List.

All the passwords are handled by the Active Directory except for username which appears on the Access Control List (ACL) on the Database. Users can access the system by providing their network credentials secured by an SSL certificate. In case of successful login, a corresponding match with the Access Control List on the database will be done where the User will be assigned a "user level" depending on the course they choose. By default, students are students and teachers belong to user level teacher. On any other case, the ACL allows some users (students) to take the role of some other user level (students become teaching assistants).

Depending on the ACL, or the user level, a certain privileges are assigned or revoked from a user.

Basically we consider the following user levels (Higher the level, lower the privileges) being important for a system like this one:

- System Administrator (level 1)
- Professor/Teacher (level 5)
- Teaching Assistant (level 10)
- Student (level 15)
- Guest (level 20)

ACL privileges or user levels are assigned by the owner of a course (a teacher) to a student or group of students or other teacher.

7.2. Data Access Control

Data Access Control takes care for accessing all the files on the server(s). This is directly linked to the ACL where the given user level or username has access to a certain RESOURCE ONLY (Files, presentation, e-documents, quizzes, forums, and similar).

Resources (Files) reside on server side but there is no VIRTUAL access to the files using the HTTP protocol. This is handled by a DOWNLOAD manager script which is re-checking the ACL for permissions to download the file. Basically an access to `http://my_server/My_course/My_File.doc` does not exist. The available access will be of the type:

`http://my_server/Download.aspx?docid=someid.`

When the download manager checks for permission, it streams the data as byte array to the user with headers included.

Resources can be hosted on several machines on the same network. Access to these machines is restricted by specific routers that separate this network from the rest of the University network.

8 Modules

In this section we present the modules of the system [2]. In the first stage of the system development are included the key features of today's LCMS, and in the next stage the system will be probably upgraded with new additional modules.

8.1 User Management

In this section are presented the user management modules and their main functionalities:

Overview

- High security supported by LDAP and SSL certificates.

Enrollment

- Students are enrolled automatically from another existing University Schedule system;
- Teachers and administrators can move students to another group if necessary.

Roles

- Roles for specific participants can be defined for each course and resource;
- Instructors can assign user roles to other users enrolled to the course;
- Instructors can create content and assign privileges.

8.2 Course Management

Below are presented the key features of course management modules:

Overview

- Flexible array of course activities – Quizzes, Resources, Assignments, Messaging, Events;
- Most text entry areas can be edited using an embedded Coolite HTML editor ;
- All grades for Assignments can be viewed on one page (and downloaded as a spreadsheet file) ;
- User logging and tracking is available upon request;
- Mail integration - copies of Messaging, if desired, are mailed in HTML or plain text to the users.

Assignment Module

- Assignments can be specified with a due date and a maximum grade;
- Students can upload their assignments (any file format) to the server - they are date-stamped.

News Module

- RSS Feed reader allows consuming feeds that are generated by administrators or Public Relations Office;
- These feeds can be customized by allowing new channel adding.

Messaging Module

- Messages are sent to the group or a single user;
- Course content can be attached to the message;

- If configured, a copy is sent to the personal e-mail.

Calendar Module

- Users can add events and system will check for conflicts;
- Users can share events;
- Shared events are shown with a different color than users events;
- Events reminder is a useful function that sends mail to the user.

Lesson Module

- Lessons are organized in a hierarchical level, where items represent folder or file.
- Navigation through the lesson can be straight forward by using tree view where the content of the selected item is shown on a grid view with a paging feature enabled.
- Page content is HTML compatible, with a full set of edit tools for the teacher
- Password protected folders if desired
- Access to updated roster

Quiz Module

- Questions can be added dynamically from an existing list of question types, such as: Multiple choice questions (radio buttons), multiple select (Checkbox), true/false, Drop Down list and Text/Essay.
- Quizzes are automatically graded, and can be re-graded if questions are text type or essay
- Quizzes can have a limited time window outside of which they are not available
- Quiz questions and quiz answers can be shuffled (randomized) to reduce cheating
- Questions allow HTML and images

Resource Module

- Files such as PDFs and Microsoft Office formats are directly embedded to the page
- Files can be uploaded (renamed, moved) and downloaded (zipped, unzipped) on the server
- Folders can be created and managed on the server
- Internal web pages (html formatted) can be created with Coolite HTML editor Internal text pages (no formatting) can be created and linked to
- External web applications can be linked to with data passed to them

BLOG Module

- Blogs are enabled to all the staff, where students are able to add comments to an existing blog post

9 Strengths of the System

Content management. The content management or resource management is done by the users for the users, so content will be always up-to date since it is teachers' responsibility to do so. This is an easy process which will reduce the time to disseminate information or expertise to the students.

Learning. The whole idea behind the LCMS system is to provide a qualitative learning content which can be easily distributed anywhere it is needed and in a form which can be easily red by users.

Increased communication. The system has features which allow normal communication between users by using the messaging module and calendar module.

Decrease the expenses. The new LCMS will save the University and students money when learning parts that were used to be printed early now are completely web-based. Example, an Online Quiz will substitute any paper printing of the same quiz.

Interoperability. The system is designed to work on all major browsers that support JavaScript.

Future use of the content. The content is stored in a file format and some parts in database. In case of radical changes in the hardware or software, the separation is already done. On a click of a button ones content can be archived and distributed using a file format or an XML format.

10 Conclusion

In the realization process of the LCMS we have used modular approach. All the above modules were first developed independently and then integrated into the final composition. Using this approach has two main benefits. The first is that modules were developed simultaneously, what saved us a lot of time. The second benefit is that the LCMS application is very scalable which means that later we can easily integrate additional modules without affecting the existing ones.

At the end, we would also mention that the main beneficiary of the LCMS system is the SEE University, who in one hand has less financial expenses and on the other hand it has a system that has been created according to the university needs.

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