



UNIVERSITY OF GOTHENBURG

Improving the outcome of e-learning using new technologies in LMS systems

**and establishing the requirements for an LMS
system in an academic environment**

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1. Abstract

Background

Studies of e-learning education programs that use LMS systems have shown that the lack of social interaction between the participants have a negative effect on the outcome. Most notable in the number of students that drop out of courses prematurely. It is therefore essential to introduce technologies that create a more interactive experience for the participants. A good approach to these problems is to have a software platform that not only supports the administrative areas of distance learning over the internet but also provide tools to support the social aspects of it.

Objective

This thesis has two objectives. The main objective is to identify the technologies that improve the results of academic e-learning education programs that are using LMS systems. Furthermore there will be a comparison between LMS systems using open source licensing and proprietary licensing. The second objective is to establish requirements for LMS systems used in an academic environment. Requirements determined to be associated with a corporate training environment will be separated and excluded from the main objective, but they will be discussed in the thesis because of their value to corporate training LMS systems.

Methods

The research method used to answer the first and main objective is a survey based analysis with a qualitative approach to the data collection. The LMS systems are analyzed from the perspective of learning, but evaluated from the perspective of Software engineering. The research method used for the second objective is literature review.

Results

Thirty requirements were established for an academic LMS system, arranged in eleven categories. The following three categories of requirements were the most important: course content management, evaluation and communication. The survey found that the most common technologies to fulfill these requirements are for course content management: assignment upload, personal file storage and course object reuse. For evaluation it was: course evaluation functions and results analysis. For communication it was: chat, wiki, forums, messages systems and collaboration systems.

Conclusions

The three most commonly referenced categories of requirements from the literature are: course content management, evaluation and communication. There is a significant difference in the requirements for LMS systems depending on what market it is developed for. The technologies that can improve the outcome of e-learning systems are: content management systems that allow the users to share and reuse course content objects, course evaluations systems that give the teacher feedback on the course from the students and communication systems such as chat, wiki, forums, collaboration systems and messages systems that improves communication between the participants and the social atmosphere. There were significant differences between LMS systems using open source licensing and proprietary licensing.

2. Keywords

Distance learning, E-Learning, Education, LMS, LMS Requirements, wikis, chat, forums, messages systems, collaboration systems, open source, corporate training,

3. Introduction

Distance learning was first mentioned in a news paper advertisement in 1728, but more conclusive evidence for the start of actual academic distance learning comes from 1833 and more organized distance learning started at the end of the 19th-century. From the beginning distance learning used physical mail correspondence between the education facility and students [25]. The first project to develop software for online distance learning started in 1981 in a higher education school in California [68]. Distance learning has since the development of national postal services quickly adopted almost all new forms of media and communication technologies [4, 5].

Distance learning programs were quick to adopt computer and internet technologies. At the same time distance learning over the internet now became known as e-learning [7, 73]. The use of internet technologies revolutionized distance learning and the number of software programs supporting it started to grow, a growth that still continues today with a constant development of new systems and introductions of new features for e-learning. The number of students participating in e-learning education programs is currently on the way to overtake traditional academic class room education [4, 56].

The new technologies that became available made it possible to develop more complex and interactive e-learning systems and today there are education centers based entirely on e-learning courses. The understanding of the importance of e-learning is growing among the teachers and the consensus among the academic leaders is that the ability for a university to offer e-learning courses is crucial for their long-term strategies [56]. Also the ability to offer high quality e-learning courses will be an important competitive advantage amongst the growing number of educational facilities [56].

For software engineers, particularly those working with development of e-learning systems, it is important to understand the requirements for e-learning systems and how they affect the users. During the planning phase of the development process it is also necessary to prioritize the requirements based on their importance. To ensure that the most important requirements are given more attention and that basic requirements are included early. It is also important to understand the correct way to implement these requirements to develop a system that more accurately follows existing conventions or standards to ensure that the system is easy to understand and learn for the end users. Furthermore it is also important to know what new technologies are available for e-learning systems or technologies that potentially could be used to support the learning process and how to use them effectively [84, 85].

There are a number of barriers or issues that have been found during research of the use of e-learning systems. Although important when studying the use of e-learning systems they are not relevant to this thesis. They will however be mentioned because of this.

The barriers are categorized as: student, faculty, organizational and course barriers according to the findings of Galusha [4].

The first category is student barriers, which are barriers that can affect the student's results [4, 51, 53, 57].

The second category of barriers is the faculty barriers, which are barriers for the people in the faculty that are responsible for the e-learning course [4, 51, 57, 68]. The concept of formative context [58] also constitutes a barrier for the faculty when adopting e-learning technologies, because LMS systems and other e-learning technologies can't act as an analog to classroom teaching but must instead be seen as an entirely new paradigm in education. Formative context can be described as how the users own subconscious use of an existing system will affect their use of a new system that will replace it, if the developers of the new systems based their design on how it should be used on how the old system should have been used. The third category of barriers is the organizational barriers, which are barriers for the organization that is responsible for the e-learning system [4, 51, 68]. The fourth and final barrier is the course material barrier, which are barriers for the development of the material used in an e-learning course [4, 51, 67]. Overall when it comes to barriers for LMS systems within an academic organization the majority of them are related to the communication needs of the students, the part of the faculty responsible for the system and the effects of the new technologies on the education process.

To summarize and further elaborate on the main problem for this thesis it is important to understand that the biggest difference between e-learning and the traditional learning process is the co-operative and social atmosphere in which the student's benefits from the interactions with the teachers and the other students. This interaction is almost entirely lost when the students participate in e-learning. Earlier in the history of e-learning the technology to support interaction with the teacher was with a telephone and the communication with other students was almost nonexistent. The Internet and e-learning technologies on the other hand has given teachers a whole new range of technologies to improve the social aspects of distance learning. [52] (page 11).

Finally the growth of e-learning has created numerous problems that need to be understood, such as the requirements for e-learning systems, the difference in requirements between academic and corporate training, the difference between open source and proprietary licensing of e-learning technology and what technologies that can improve the learning experience and outcome of the e-learning education program.

3.2 Definition of the terminology

The naming convention used to describe the different kinds of e-learning systems is not well defined and there is no generally accepted naming convention. The most common name used to describe systems that manages e-learning programs is LMS, short for learning management system and LMCS, short for learning management content system. The main difference in requirements is that LMCS systems have the ability to create and modify the course content objects. Course content objects are the individual parts that make up an LMS course, for example PDF files, word documents, pictures, diagrams, media files and test forms [1, 26, 73].

The name used for the type of e-learning system that is the focus of this thesis is LMS (Learning Management System).

Table 1 contains definitions for the names used for e-learning systems in this thesis.

Different names used in the field of e-learning	
Distance Learning	The umbrella term for all forms of education and technologies used to facility learning over a distance. All subsequent names in this table belong under this name [4].
E-learning	The umbrella term for all forms of distance learning over the internet. Replaced distance learning when internet and computer technologies were adopted by institutions offering distance learning courses [3].
CSM	Course Management System. One of the earliest descriptions and definitions used to describe an e-learning system. Rarely used to today, but when used it describes the most basic functionality for an e-learning system. [14]
LMS	Learning Management System. The most common name found in the research of e-learning and most frequently used when marketing e-learning systems and has come to almost entirely replace the name CSM in the context of e-learning. [14]
LMCS (or LCMS)	Learning Management Content System. Most commonly used instead of LMS to describe e-learning systems that have the ability to create and modify the information within individual course objects, that is used for corporate training and that have advanced integration capabilities most commonly with systems used for human resource management. This name is often used when describing or marketing advanced LMS systems in general [19].

Table 1: Definitions of acronyms in the thesis

3.3 Problem area and research question

In order to better understand LMS systems and how they are used it is necessary to establish the most important requirements. This will also help developers prioritize the requirements during the development process [84, 85]. The requirements will also be an important part of the survey.

Large scale studies of students participating in E-learning programs [53] have shown that the lack of social interaction is the most severe problem and that the percentage of students that drop out of e-learning courses is much higher than for regular classes [1]. Therefore, it is essential to introduce new technologies to create a more interactive experience with the course in order to improve the social atmosphere that can help mitigate the social isolation of distance learning.

Because of this the main issue for this thesis is how new technology can be used to improve the learning process and outcome of e-learning education programs. This thesis will focus on e-learning systems for the academic arena, but the difference in requirements to support corporate training will be mentioned. The literature review will establish the requirements for an LMS system and these results will be used for the survey. The survey will show how different technical solutions are used to fulfill the requirements and how they can improve the outcome of the e-learning education program. These technical solutions will also be described from a software engineering perspective to give suggestions to developers of LMS systems.

As with a lot of other software there are both proprietary and open source licenses available and because one of the areas covered in this thesis are the requirements, it can be of interest to find out if there are any differences between LMS systems using either of the two software licenses.

3.4 Research questions

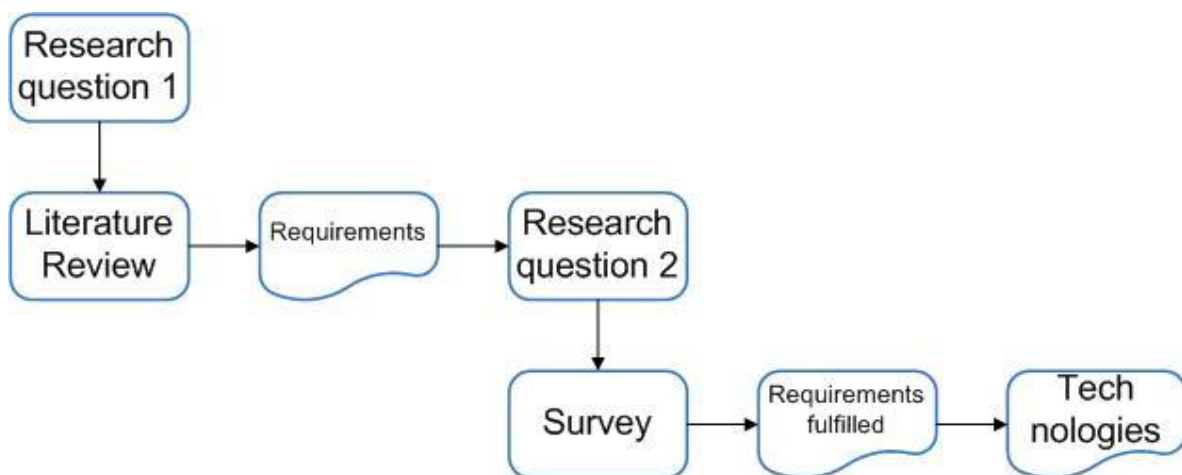
There are two research questions for the thesis:

1. What are the requirements for an LMS system in an academic environment?
2. How can new technologies fulfill these requirements and improve the outcome for the students and teachers using the LMS systems?

3.5 Methods

This thesis uses two different research methods. The first method is a literature review that will answer the first research question. The literature review method is used because it makes it possible to summarize the current state of research in the area of e-learning using LMS systems.

The second method used is a survey created with the requirements established by the literature review. The survey is used to answer the second research question because a literature review will not be sufficient and a more in-depth view of current LMS systems is needed. The survey will compare a number of LMS systems and the result will indicate how the previously established requirements can be fulfilled and which technologies that can be used to improve the outcome of e-learning education programs using LMS systems. Flowchart 1 below shows this process:



Flowchart 1: Steps in the thesis project

4. Design of literature review

The literature review uses articles [1] to [21] to establish the requirements most referred to as being of importance. The requirements are divided into 11 categories based on the categories used in the following articles: [1, 15, 17].

In order to determine which requirements are the most important to improve an LMS system the categories will be sorted depending on how many of the articles argue of their importance. The requirements within the categories are taken from the articles.

The result is a list of the categories with the requirements for an LMS system aimed to the academic arena. The 11 categories of requirements are:

Course content management

Course content management is the category for requirements on how the system manages course content objects, assignments, sharing and reuse of course content objects and other information.

Evaluation

This category is for the requirements on how the system supports feedback from the students through course evaluations, how the results of the evaluations are presented and how the results can be analyzed, either inside the application or exported from the system to be analyzed with another program.

Communication

This category contains all requirements for how the system supports different types of synchronous and asynchronous communication between the students and the teacher as well as between the students themselves. The difference between synchronous and asynchronous communication is that synchronous communication is in real time for example chat, VoIP or video-conferencing, whereas asynchronous communication is not, for example forums, wikis and mail [3].

Progress monitoring

This category contains requirements for how the system monitors the student's progress in the courses or programs by tracking completed assignments or grades.

Administration

This category is for requirements on how the system can be administrated and modified to fit individual organizations or courses. The administrators of the LMS system should have the ability to give different levels of access to the users depending on the user's role. For example a teacher need more access and control of the information and course content objects then the students. They should also be able to control the access to the information in the system [1].

Third party integration and standards support

This category is for requirements on how the system handles integration with third party systems and external information sources such as databases and digital libraries, the system should also support multiple software platforms and software development standards for LMS systems.

Third party content

This category is for the requirements on how the system handles content developed on other systems or created by third party organizations using existing frameworks and content created using third party programs. For example text documents written with Microsoft word or open office.

Usability

This category is for requirements on how the user interface on the system should be designed to make it easy to use and easy to get started with and also easy to learn.

Configuration and modification

This category is for requirements on how easy the system is to configure and modify and how it can be adapted to work within existing server environments.

Technical requirement

This category is for requirements on how the system should be able to manage heavy communication traffic and workloads as well as scaling when the user base increases.

Learning and pedagogical requirements

This category is for requirements on how the system supports the learning process because it is an important part of course material development to include visual imagery and interaction and remove unnecessary information.

5. Results of literature review

5.1 Requirements for LMS systems in an academic environment

This chapter contains the results of the literature review. The categories are sorted by how often the category is mentioned in the articles for the literature review. The most discussed categories are the most important and have the largest positive impact on the results of e-learning courses using LMS systems. Each individual requirement in the categories is the most commonly referred to requirements in each category. They are also sorted after number of references.

5.1.1 Course content management

Recommended by [1, 2, 5, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20]

1. The system should support storage of personal files that are uploaded by the users [9, 1, 7, 8, 10, 13, 14, 15, 16, 17, 18].
2. The system should support uploads of course assignments from the students to the course page [2, 1, 5, 7, 8, 9, 10, 13, 14, 15, 17, 20].
3. The system should support reuse and sharing of course objects between the teachers [18, 1, 7, 8, 9, 10, 13, 14, 15, 19].
4. The system should support a digital library where course content objects and information can be shared between all users of the system [18, 1, 7, 8, 9, 10, 11, 13, 14, 15].

5.1.2 Evaluation

Recommended by [1, 2, 3, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17]

5. The students should have the ability to evaluate the courses after they have completed them [1, 3, 5, 6, 7, 9, 10, 12, 14, 16].
6. The person responsible for the course should be able to view the answer on a results page [2, 1, 3, 5, 6, 7, 10, 12, 13, 15, 17].
7. The person responsible for the course should be able to analyze the answers [7, 1, 3, 5, 6, 7, 10, 11, 15].

5.1.3 Communication

Recommended by [1, 3, 4, 5, 6, 8, 9, 13, 14, 15, 16, 17, 19]

8. The system should be able to support text based chat [5, 3, 4, 6, 8, 14, 15, 17, 19].
9. The system should be able to support forums [5, 1, 3, 4, 6, 8, 9, 14, 15, 17].
10. The system should be able to support wikis [5, 3, 6, 8, 13, 15, 19].
11. The system should have an internal messages system [5, 3, 6, 8, 9, 14, 15, 17].
12. The system should be able to support collaboration systems [5, 3, 6, 8, 14, 15, 16].

5.1.4 Progress monitoring

Recommended by [1, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19]

13. The system should have the ability to track the students overall progress [9, 10, 11, 12, 13, 14, 15, 17, 19].
14. The students should have access to a “grade book” or similar in which the student’s results can be accessed by them as well as the teachers [1, 10, 12, 13, 16, 17, 18].

5.1.5 Administration

Recommended by [1, 8, 10, 11, 14, 15, 16, 17, 18, 19]

15. The system should make sure that the student is eligible to take a certain course [1, 10, 1, 8, 14, 15, 18, 19].
16. The system should have different accounts (student account, teacher and admin account) for different roles [10, 11, 1, 8, 16, 17].
17. The person responsible for the course must be able to decide who can access the material [10, 11, 1, 8, 18, 19].

5.1.6 Third party integration and standards support

Recommended by [1, 5, 8, 13, 15, 16, 17, 18, 19, 20]

18. The system should be compatible with other third party software to simplify integration. [8, 5, 1, 16, 19]
19. The system should be able to integrate with external research databases and digital libraries [8, 5, 1, 15, 18].
20. The system should support common standards and frameworks such as AICC [24], IMS [23], SCORM [22] [8, 1, 16, 17].
21. The system should be able to run on multiple hardware and software platforms [13, 5, 15, 20].

5.1.7 Third party content support

Recommended by [1, 8, 7, 13, 15, 17, 18, 19, 20]

22. The system should be able to handle content created by third party developers [1, 7, 8, 13, 18].
23. The system should be able to handle content from different third parties (flash, MP3, video formats etc.) [1, 7, 8, 15, 17].
24. The system should support content developed on third party platforms (MS & open office, photo-shop, video and audio editing software etc.) [1, 7, 8, 19, 20].

5.1.8 Usability

Recommended by [1, 8, 12, 15, 17, 18, 20]

25. The system should be easy to use and learn by the students and teachers [1, 8, 17, 15, 18].
26. The system should be fully accessible through a web browser [20, 1, 17].

5.1.9 Configuration and modification

Recommended by [1, 8, 15, 17, 18]

27. The Administrators should be able to modify the systems source code or have access to an API/SDK [1, 8, 15, 17, 18].

5.1.10 Technical requirements

Recommended by [7, 15, 17, 18]

28. The system must be reliable under heavy workload [7, 15, 17].
29. The system must be able to handle growth in the number of users or information [7, 17, 18].

5.1.11 Learning and pedagogical requirements

Recommended by [2, 6, 12]

30. The system should support interactive course content object. [2, 6, 12].

5.2 Requirements for corporate LMS systems

These categories and requirements are sorted in the same way as the previous one. They are separated from the above result because they are not used for LMS systems in an academic environment. But they are however important to mention because they are often used in LMS systems for corporate training.

Security

An important part of an internal corporate training LMS is the security of the content because it may contain information valuable to the company.

Advanced skills management

An important part of a corporate LMS system is knowledge management and because of this a corporate training LMS system should be able to integrate with the Human resource department's databases to be able to better track the employee's competences and skills

Scalability, usability and stability

There are more technical requirements for a corporate LMS system than for an academic LMS system, because of the often higher demand for high availability.

Content modifications

The main difference between an LMS and an LMCS is that a LMCS should have the capacity to create and modify course content as well as all the other requirements. This makes the system a lot more complex and expensive and less suitable for an academic environment [10].

Personalization and system adaption

The ability for the system to handle personalization of the content is an important part of advanced LMSs, [12] [20] (page 4). Although these requirements are hard to implement and makes the system more complex and expensive and such requirements are not as necessary for an academic LMS system.

5.2.1 Security

Recommended by [1, 7]

1. Should be able to protect the content from unauthorized use [1, 7].
2. Should have a high level of user account security [1, 7].

5.2.2 Advanced skills management

Recommended by [1, 13]

3. The system should be able to integrate with systems used by Human resources [13].
4. The system should support knowledge management [1].

5.2.3 Scalability, usability and stability

Recommended by [7]

5. The system should have high availability [7].
6. The system should be scalable [7].
7. The system should be stable [7].

5.2.4 Content modification

Recommended by [10]

8. The system should provide the teacher with the possibility to modify course content objects after publishing the course [10].

5.2.5 Personalization and system adaption

Recommended by [12, 20]

9. The system should adept to the user's needs [12, 20].

6. Analysis of literature review results

The most recommended category of requirements in the literature review was course content management. This is likely due to the fact that the requirements in this category is about how an LMS system handle the courses, course content objects, submission of assignments as well as the management of other course related material. All of which is a part of the most basic functions of any LMS system [14]. The second most recommended requirement is evaluation which is about how an LMS system handles evaluations of the courses by the students and manages the results. This is an important category because it allows the teachers to see what the students think about the courses and use that information to further develop the courses, which is an important part in improving the overall result of the e-learning courses. The third most recommended category of requirements is communication which is about how an LMS system supports communication between the students and the teachers. This is important part in making the students feel more involved in the e-learning course.

The category learning and pedagogical requirements were the least recommended category in the literature review. This is a notable, because the subject of pedagogy and the learning process are very important for traditional classroom education. The reason that it is not higher on the list is likely that e-learning has a reversed view on this. Technology is not developed based on studies of pedagogical theories but rather technological solutions are evaluated after they have been implemented in LMS systems for e-learning. Also pedagogical theories are largely ignored by the developers of LMS systems and there is a lack of explanation for how to effectively use the tools and technologies that they have implemented in their LMS systems [89, 90(page 17-20)]. This also reflects on the research of LMS system and explains why the pedagogy and learning category is the least recommended in the results of the literature review.

The review of the academic literature on the requirements for LMS systems highlights the difference in requirements for an LMS system depending on who it is developed and marketed to. The categories of requirements in “5.2 functional requirements for corporate LMS systems” are not relevant for an LMS system aimed at an academic environment [13, 19]. They are more important for the corporate environment, where the growth of e-learning systems has lead to a trend of increased investments in technologies that can track the employee’s skills and competences, because technology companies today compete as much for mindshare [21] as they do for market share. Where market share relates to the total value of all their sales transactions, mindshare relates to the total number of technology professionals who are competent with the technology that they are marketing. Because of this and the higher focus on return of investment there are several requirements that are more suited to the corporate training environment.

The one requirement for a corporate LMS systems that is considered the most important is advanced skills management, also called knowledge management. The important part of this requirement is that a corporate training LMS system should be able to integrate with the companies HR departments systems. This will enable the company to better monitor the available skills within the company and the development of their employee's skills. [1]

Another difference between the corporate and academic environment is the goal of the training. In an academic environment the goal is to educate the customers but in a corporate environment the goal is to educate the employees [13]. Training is an important part of most company processes, not only HR. All other process within a corporation can benefit from training, and facilitating and improve this learning processes is key to improve the efficiency within the organization. Examples of these processes are management, research and development and production [13, 75].

As mentioned the difference between corporate training and academic education is the focus of the training. For the corporation this focus is knowledge management. Knowledge management is vital to adapt to the organization because of the rapid change found in many markets. If a corporation takes a passive stands towards this change and only use what they already know, they may enter terminal decline and become obsolete. Therefore it is of vital importance not only to manage the knowledge within the corporation but also to develop it. Also because of the rapid change in the modern market place it may not be possible to catch up to the competition but the corporation must always struggle to be innovative with knowledge management. It is therefore important to have a corporate learning strategy that involves the HR and corporate trainers and follows current trends in order to remain competitive [74, 75].

6.1 Selecting requirements for the survey

In order to narrow down the scope of the survey and make it more manageable only requirements from the most referenced categories of requirements will be used to create the survey. These are the most referenced categories of requirements and because of this the requirements from those categories will have the most positive impact on the result of the e-learning courses using LMS systems. Because these requirements are the most discussed in the referenced literature it can be assumed that they have the most positive affect.

These categories of requirements are:

Course content management

1. The system should support storage of personal files that are uploaded by the users.
2. The system should support uploads of course assignments from the students to the course page.
3. The system should support reuse and sharing of course objects between the teachers.
4. The system should support a digital library where course content objects and information can be shared between all users of the system.

Evaluation

5. The students should have the ability to evaluate the courses after they have completed them.
6. The person responsible for the course should be able to view the answer on a results page.
7. The person responsible for the course should be able to analyze the answers.

Communication

8. The system should be able to support text based chat.
9. The system should be able to support forums.
10. The system should be able to support wikis.
11. The system should have an internal messages system.
12. The system should be able to support collaboration systems.

6.2 Design of the survey

This is a survey based analysis with a qualitative focus on the data collection that will answer the second research question, which is what technologies can be used to fulfill the requirements and improve the outcome of e-learning using LMS systems. The survey will use a selection of the three most important categories of requirements established by the literature review. The systems in the survey will individually be controlled to find out how many of the requirements they support. The data will be collected from the available material provided by each developer on their websites. Materials such as specifications, manuals, features lists, developer guides and user support forums. If the developer has a demonstration site with the LMS system available it will also be used. Other sources that will be used are the referenced articles.

The systems used for this survey are twenty LMS systems, ten using the open source license model and ten using the proprietary license model. The reason to choose twenty LMS systems is because a common sample rate in articles comparing LMS systems is around ten [12, 17]. Thus selecting 10 from each different type of software license provide a sufficient sample rate and the combined results of the twenty LMS systems will provide an accurate overview of the general support for the LMS systems available today. LMS systems with the two license models are used, to highlight any differences between LMS systems using either of the two types of software licensing and if there is any difference in support for the requirements.

The selection criteria for the LMS systems are:

- First if it is marketed by the developer as an LMS system primarily for an academic environment, because of the focus of this thesis.
- Secondly how large user base the LMS system has, meaning the total number of registered users for all existing installations of the LMS system. The reason for this is to make sure that the survey covers the largest part possible of the market for LMS systems.
- Lastly if the LMS systems is mentioned in any of the articles used in the literature review.

For any of the LMS systems to count a requirement as fulfilled the corresponding feature or function that fulfills the requirement in the LMS system have to be included in the latest official version for that LMS system. This is because many of the LMS systems support and encourage third party development of plug-ins and add-ons, which can add functionality to the LMS system that would correspond to a requirement and thus count as supported. If these instances would count the result would be questionable as it would not be possible to determine which requirement each individual LMS system natively supports. It would give the LMS systems that support plug-ins and add-ons an unfair advantage and it would be harder to duplicate the survey.

The survey will determine if the LMS systems support the following requirements:

Course content management

1. Assignment upload, uploads of course assignments for the students
2. Personal file storage, for the users
3. Course object reuse, possible for the teacher to create courses from existing course objects
4. Digital library, possible to share course objects and other content

Evaluation

5. Evaluation, possible for the student to evaluate the course
6. Result page, results of the evaluation for the teacher
7. Results analysis, tools to analyze the result

Communication

8. Support for Chat
9. Support for Forum
10. Support for Wiki
11. Support for Messages
12. Support for Collaboration system

Data Collection template

The following table (Table 2) is a template for the data collection in the survey and will be used to display the result for each individual LMS system.

Two types of data will be collected. The first type is whether the requirement is supported or not. It can be only yes or no, partially supported requirements by an LMS system does not count as supported. The second type is what kind of technology is used to implement the requirement and how it can be used. This means that the programming language used to implement the requirement will be mentioned and after that a short description of how it can be used in the system.

(System name and current version)		
Requirement	Supported	Technology used, and how it is used in the system.
1. Assign. Upload		
2. PFS*		
3. COR**		
4. Digital library		
5. Course evaluation***		
6. Results page		
7. Results analysis		
8. Chat		
9. Forum		
10. Wiki		
11. Messag.		
12. CS****		

Table 2: LMS systems evaluation form

* Personal file storage

** Course Object Reuse

*** Course evaluation capacity

**** Collaboration System

7 Results of the survey

The following chapter contains the results of the survey and analysis of the findings. First are all of the results presented for each individual LMS system. After that is a summary of the results (*Table 23*). Lastly is an analysis of the results and observations made during the survey.

7.1 Open source

7.1.1. Moodle [27, 77]

Moodle (Modular Object-Oriented Dynamic Learning Environment) is one of the largest open source LMS systems and have about 40 million users [76]. It is primarily marketed to the academic arena and it is written in PHP. Figure 1 show the course setup page in Moodle, which is used to create courses.

Moodle version 2.0.1		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script. The teacher can view the student's uploaded assignments from the course page. Assignments can be uploaded but submitted at a later time. The teacher can grade and comment the assignment directly from the upload page. Assignments can have different status, such as draft or send for marking.
2. PFS*	Yes	PHP script. Personal files can be uploaded to the users account and can be made private or shared with other users.
3. COR**	Yes	PHP script. Support for a file repository, were the users can add files and share them with the other users. The file repository is managed with an interface called file picker. The file picker interface has 4 different input areas. Files are organized in a tree structure.
4. Digital library	No	
5. Course evaluation***	Yes	PHP script. Surveys are used to get feedback from the students, can be added by the teacher to the course. Currently three types of standard surveys available: COLLES, ATTLS and Critical incident. Although another function called choices can be used to create custom evaluations.
6. Results page	Yes	PHP script. Results of the surveys can be seen on the results page which is linked on the main page. Results can be exported as a open office spreadsheet, excel or text document.
7. Results analysis	Yes	PHP script. Only two to the built in survey forms COLLES (Constructivist On-Line Learning Environment Survey) [86] and ATTLS (Attitudes to Thinking and Learning Survey) [87] support analysis of the results, with their own specific graph tool.

8. Chat	Yes	PHP-script and JavaScript. Chat can be added to the course page by the teacher account. Possible to add chat sessions to the calendar. Two versions of the chat available; one built in to the user interface, the other launches as a popup window. Chat logs can be saved.
9. Forum	Yes	Built in using PHP script. There are four basic types of forums: single discussion topic, one discussion per user, Q & A and general use. Forums can be added to any course from the course page by the teacher account. Rating of posts by the users is possible.
10. Wiki	Yes	Built in using PHP script, HTML. Wikis can be added from the course section as an activity. Only teacher accounts can add wikis. Support for non-text resources such as images, audio and video, that can also be downloaded from the wiki
11. Messag.	Yes	Built in using PHP script, Supports communication with outside mail systems. Users can send and receive messages from other users. Notices of Changes and updates to courses, grades and communication are sent to the messages system inbox. Support for IMAP/POP3/NNTP mail standards.
12. CS****	Yes	Supports to third party developed collaboration systems Wimba [49] and Webex [88] which are highly integrated into Moodle. The collaboration systems are run as external windows and are launched from a link in the system.

Table 3, Results for Moodle

The screenshot displays the Moodle 'New Course' management interface. At the top, it shows 'Demo Site » CF101' and 'You are logged in as Admin User (Logout)'. Below this are buttons for 'Turn editing off' and 'Turn student view on'. The main content area is titled 'Topic outline' and contains a 'News forum' section with three topics. Each topic has a title, a description, and two buttons: 'Add a resource...' and 'Add an activity...'. The left sidebar contains several navigation menus: 'People' (Participants), 'Activities' (Forums), 'Search Forums' (Advanced search), 'Administration', and 'Courses' (New Course, Moodle Features, Demo, All courses...). The right sidebar contains 'Latest News' (Add a new topic...), 'Upcoming Events', 'Recent Activity' (Activity since Saturday, 2 September 2006, 12:27 AM), and 'Blocks' (Add...).

Figure 1: Moodles course management page

7.1.2 OLAT [28, 78]

OLAT (Online Learning And Training) is described as an web-based LMS developed specifically for the academic organization and it is written in Java. Figure 2 shows course management page in OLAT. This page is used to administrate and edit an existing course.

OLAT version 7.0		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	Java script. Assignment files can be uploaded to a drop box and it is also possible to comment on the uploaded file a function called "file dialog". Notifications on the file dialog can be sent to an external email system or the built in notification system.
2. PFS*	Yes	Java script. Personal files can be uploaded to a folder on the user's personal page. The uploaded files can be submitted to a course drop box.
3. COR**	No	
4. Digital library	No	
5. Course evaluation***	Yes	Java script. Feedback from the students can be collected using the questionnaire function that can be added as a "course element". The teacher can then create the questionnaire using the built in tool.
6. Results page	Yes	Java script. The results of the questionnaire can only be exported as an excel spreadsheet when the questionnaire is finished.
7. Results analysis	No	
8. Chat	Yes	Java script using Ajax methods Chat launches as a popup window. There are two ways to use the chat function, either with invited users in a project group or with one other user from the users currently logged in. Users can change their status if the want to be contacted or not. The user's status changes automatically when using the built in test function.
9. Forum	Yes	Java script. Forums can be added to a course as a "course element" or to a project group. The forum can handle attachments. The forum discussions can be archived as a zip file together with the attachments. Notifications on modifications to the forums the user is subscribing to can be sent to an external email or to the built in notification area called "My notifications".
10. Wiki	Yes	Java script. Wikis can be added as a "course tool" to a course from the "course editor" page. Wikis can be shared between courses. Wikis can by default be edited by all user registered to the course but the wiki can be locked from editing under the access menu.
11. Messag.	No	
12. CS****	No	

Table 4, Results for OLAT

The screenshot displays the OLAT course management interface. At the top, there are navigation tabs for Home, Groups, Learning resources, and My Course. The main content area is titled 'My Course' and shows a 'Title and description' editor. The editor includes fields for 'Short title' and 'Title', both containing 'My Course'. The 'Description' field is a rich text editor with a toolbar for bold, italic, underline, bulleted list, numbered list, link, unlink, paragraph, font family, and font size. Below the description field is a 'Path' field with the value 'p' and a 'Display' dropdown menu set to 'Title, description and content'. A 'Save' button is located at the bottom of the editor. To the right of the editor, there is a 'Legend' section with icons for visibility, configuration errors, and ready-to-publish status. On the far right, there are two vertical panels: 'Editor tools' (Storage folder, Course preview, Publish, Close editor) and 'Insert course elements' (Structure, Single page, External page, CP learning content, SCORM learning content, Forum, Wiki, Podcast, blog, file dialog, Folder, Assessment, Task, Topic assignment, Test, Self-test, Questionnaire, Enrolment, E-mail, Calendar). Below these panels is a 'Modify course element' section with Delete, Move, and Copy options. The footer of the page shows the user is logged in as 'amuster', there are 5 people online, the system is powered by University of Zurich, and the version is OLAT 6.3.0 (Build 2238), N2.

Figure 2: OLATs course management page

7.1.3 Claroline [29, 79]

Claroline is described as a collaborative e-learning and e-working platform. It is marketed to the academic arena and is written in PHP. Figure 3 shows a course page in Claroline as seen by the student. To the left are available course objects and tools.

Claroline version 1.9.7		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script. Assignment upload folder can be added to a course page. Also possible to add an automated feedback notification when an assignment is uploaded or when a deadline has passed. The teacher can view the number of uploaded assignments for each student.
2. PFS*	No	
3. COR**	No	
4. Digital library	No	
5. Course evaluation***	Yes	PHP script. No built in dedicated tool for course evaluation but the built in test editor can be used to create course evaluations.
6. Results page	Yes	PHP script. Results can be accessed by the teacher and shows the score/answers for each student. The result can also be exported as a CSV file which can be opened in a text editor or a spreadsheet program.
7. Results analysis	No	
8. Chat	Yes	PHP script. Chat function can be added to project group members in a course or to all members in a course. Chat is built directly into the user interface.
9. Forum	Yes	PHP script, Forum function can be added to project group members in a course or to all members in a course. The forum only has basic functionality.
10. Wiki	Yes	PHP script. Wiki function can be added to project group pages or to all members in a course page. Security settings for which users can access the wiki is available.
11. Messag.	No	
12. CS****	No	

Table 5, Results for Claroline

- ☰ Course description
- 📅 Agenda
- 📄 Announcements
- 📄 Documents and Links
- ☑ Exercises
- 📌 Learning Path™
- 📄 Assignments
- 🗣 Forums
- 👥 Groups
- 👤 Users
- 💬 Chat
- 📖 Wiki

Figure 3: Clarolines course homepage

7.1.4 Docebo [30, 80]

Docebo is described as an open source software package for e-learning and marketed to the corporate and academic arena and is written in PHP. Figure 4 shows the chat function which is launched as a separate window from the system. Figure 5 shows the forum tool.

Docebo version 4.0.4		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script. Assignment drop boxes can be added to a course by selecting it from the list of “learning objects” in the course properties page.
2. PFS*	Yes	When a student subscribes for a course a “course file” is created in the user’s main page. Course files contain information about the course as well as course materials. The student can upload additional course material if need.
3. COR**	No	PHP script. The teacher can choose to index all or selected course objects to the built in “content library”. Content can also be added independently. The indexed content in the content library can then be searched by the users.
4. Digital library	No	
5. Course evaluation***	Yes	PHP script. Course evaluations can be performed by adding a “questionnaire” to the course from the test menu. Questionnaires have similar structure as the test but with fewer question types.
6. Results page	Yes	PHP script. The results can be viewed by clicking on the “statistics by object” function after the name of the questionnaire.
7. Results analysis	No	
8. Chat	Yes	PHP script, XHTML and JavaScript. All communication tools added to a course can be found in the “collaborative area” for the course. Chat can be added to the collaborative area of the course. The chat tool adds the user when they enter the collaborative area and display them in the user list.
9. Forum	Yes	PHP script. The students can create forums in the collaboration area and then invite other users; if no users have been invited the forum is available to all course members. The discussion in the forum can be exported as a .CSV file.
10. Wiki	Yes	PHP script. Wikis can be added to the collaborative area and then all students subscribing to the course can modify the information. The wiki has a wiki overview function to see all pages within the wiki and page revision site.

11. Messag.	Yes	PHP script. Docebos built in messages system supports file attachments and the messages can be given priorities.
12. CS****	Yes	Support for third party collaboration systems; dimdim and teleskill. The collaboration systems are integrated with Docebo but launched as external applications.

Table 6, results for Docebo

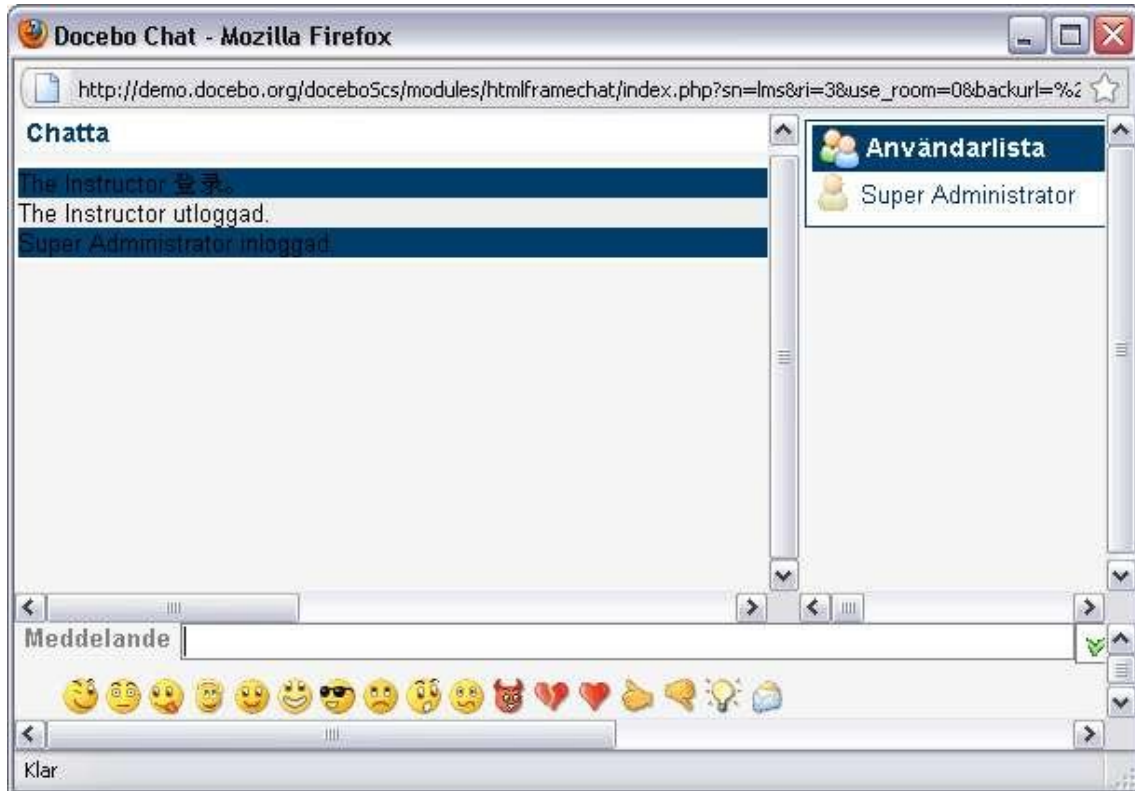


Figure 4: Docebos chat in an external window

Forum

Title	Description	Threads	Posts	Last message.					
Ask a teacher	You are welcome to answer questions posted in the Ask a Teacher forum!	2	5	31-08-2010 13:42 Hello ... (by: The Administrator)	▼	▲			
IT problems	This forum is about the IT problems and solutions.	0	0	None	▲				

Figure 5: Docebos forum function

7.1.5 Dokeos [31, 81]

Dokeos is described as a SCORM-compliant open source learning suite with 3 million users and extensive support for third party plug-ins. IT is marketed to both the corporate and academic arena and is written in PHP with AJAX JavaScript methods for visuals. Figure 6 shows Dokeos built in collaboration system.

Dokeos version 2.0		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script with AJAX JavaScript methods. Assignment uploaded can be added to the course by creating a drop box in the course page. The student and teacher can comment on the uploaded file. The teacher can access the uploaded files and comments by clicking on the drop box in the course page.
2. PFS*	Yes	PHP script with AJAX JavaScript methods. The student can uploads files to a personal drop box and can then share it with other students or submit it to a course drop box.
3. COR**	Yes	PHP script with AJAX JavaScript methods. Course objects and other information can be shared through Dokeos "lectures library".
4. Digital library	No	
5. Course evaluation***	Yes	PHP script with AJAX JavaScript methods. Built in support for course evaluations, called surveys. Surveys can be added to the course as a tool and have support for many different types of questions.
6. Results page	Yes	PHP script with AJAX JavaScript methods. Results from the evaluation can be accessed by accessing the survey reporting tool.
7. Results analysis	Yes	PHP script with AJAX JavaScript methods. The survey reporting tool can also help the teacher analyze the survey results.
8. Chat	Yes	PHP script with AJAX JavaScript methods. Chats can be added to the course page or group page and used to communicate with the students. Chat sessions can be archived.
9. Forum	Yes	PHP script with AJAX JavaScript methods. Forums can be added to any course or group by selecting it from the tools menu in the course page. The discussions in the forum can be viewed in three different ways: flat, threaded and nested.
10. Wiki	Yes	PHP script with AJAX JavaScript methods. Has a built in wiki and Support for several third party wikis that can be added as course tool or within a group.
11. Messag.	No	
12. CS****	Yes	Built for Dokeos using PHP and AJAX JavaScript methods. Dokeos have extensive collaboration system support, primarily through the use of plug-ins. Support

	<p>for collaborative authoring of documents, PowerPoint presentations and video conferencing. The built in collaborative system can be added to the course or group as a “virtual meeting” or “virtual class” function. This function support chat video conferencing and virtual whiteboard.</p>
--	---

Table 7, Results for Dokeos

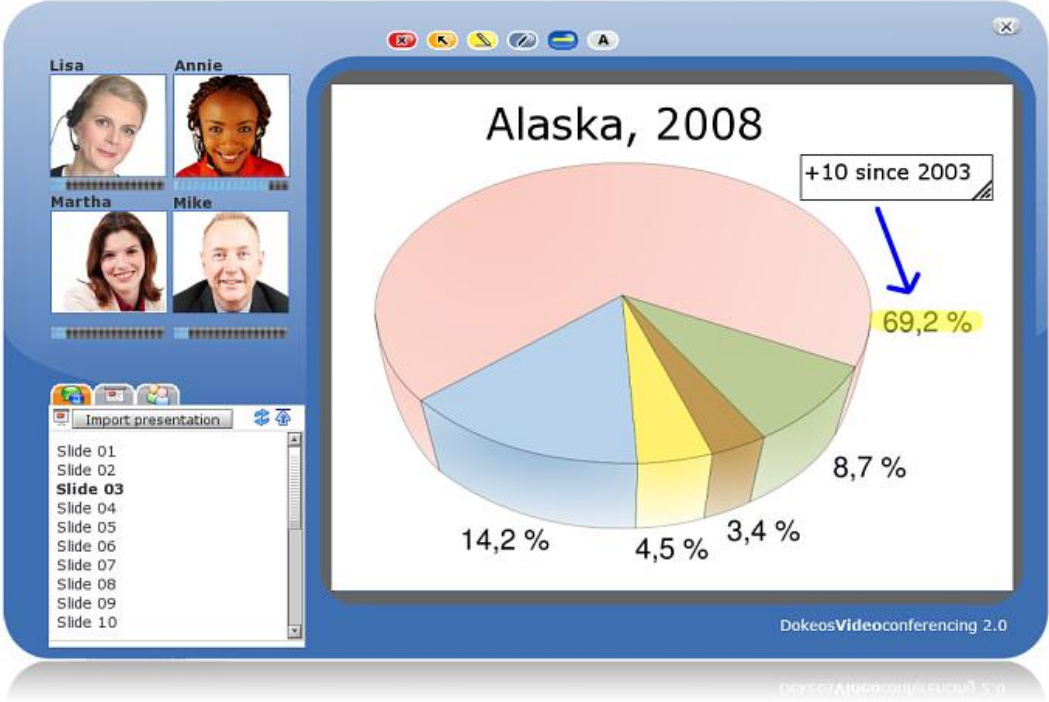


Figure 6: Dokeos built in collaboration system

7.1.6 ILIAS [32]

LIAS (Integriertes Lern-, Informations- und Arbeitskooperations-System [German for "Integrated Learning, Information and Work Cooperation System"]) is described as an open source web-based learning management system. Ilias is marketed to both academic institutions and corporations and is written in PHP with support for JavaScript and AJAX functions. Figure 7 shows a course page in ILIAS when logged in as a student.

ILIAS version 4.0		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script, JavaScript. A folder for uploads of assignments can be added to any the course page by the teacher from the course edit page.
2. PFS*	No	
3. COR**	Yes	PHP script, JavaScript. Course object reuse is supported by the systems "media pools" where course objects can be accessed and maintained by the teachers.
4. Digital library	No	
5. Course evaluation***	Yes	PHP script, JavaScript. Course evaluation can be added to the course as a survey tool. The survey function has different types of questions and the survey can be exported as an XML file.
6. Results page	Yes	PHP script, JavaScript. Survey results can be accessed from the course repository by clicking on the evaluation link next to the title of the survey
7. Results analysis	Yes	PHP script, JavaScript. The evaluation page also contains functions to analyze the result such as percentage of each response and the result in a bar chart.
8. Chat	Yes	PHP script, JavaScript. Chat rooms can be added to the course repository. The function shows who is only and what chat rooms are currently available. The user can switch to any chat room on the list.
9. Forum	Yes	PHP script, JavaScript. Forums can be added to the course repository. Activity in the forum can be sent as notifications to the users internal mail account.
10. Wiki	Yes	PHP script, JavaScript. Simple wikis can be added as objects to the course repository and have built in search function.
11. Messag.	Yes	PHP script, JavaScript. Built in messages system, called internal e-mail. Used for communication with other users and to receive notifications from the courses and the forums.
12. CS****	No	

Table 8, Results for ILIAS

ILIAS Demo Logged in as Learner Benjamin Williams

Personal Desktop Repository Search Mail (1 New) Last Visited

Repository » Features and Scenarios (English) » Course Management » Sandbox » testcourse2




testcourse2

testing

Content Info Settings Members Metadata Export Permissions Show Member View

View Manage Text/Media Editor + Add New Item

Content

-  stuff ▼ Actions
-  test ev
Status: Offline ▼ Actions
-  testwiki
Status: Offline ▼ Actions

News
(1-1 of 1)

Forum: test forum
1 Posting has been add
Details:

[Edit](#) [Add](#) [Settings](#)

Calendar
< December 2010

W	Su	Mo	Tu	We	Th
48	28	29	30	1	2
49	5	6	7	8	9
50	12	13	14	15	16
51	19	20	21	22	23
52	26	27	28	29	30

Data

[Add Appointment](#)

Permanent Link: http://demo.ilias.de/goto.php?target=crs_2210&client_id=dem ▼ Add to Bookmarks

powered by ILIAS (v4.1.2 2010-10-28)

Figure 7: ILIAS course management page

7.1.7 eFront [33]

eFront is described as an open source e-learning platform and it is marketed to both academic organizations and corporations and it is written in PHP with AJAX JavaScript. Figure 8 shows eFronts digital library called “File manager” in the system. It can be used to store and share course objects and information between the users.

eFront version 3.6.8 community edition		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script. The teacher can create “projects” for the courses for the students to upload files to. The teacher can then see all the uploaded project files from the course page. The files can be downloaded one at the time are all at once as a zip file. The teacher can also comment and grade the uploaded file.
2. PFS*	Yes	PHP script. Personal files can be uploaded to the user’s personal account.
3. COR**	Yes	PHP and AJAX methods. Course objects can be shared and reused through a simple interface that supports “drag and drop” with AJAX.
4. Digital library	Yes	PHP and AJAX methods. File sharing can be performed with the built in “digital library”. The digital library can be used to share file with all the users in the system. Multiple files can be uploaded as a zip file and then automatically unzipped in the file manager.
5. Course evaluation***	Yes	PHP script, course evaluations can be performed with the built in survey tool. The teacher can create a survey for the course. Supports several different types of questions.
6. Results page	Yes	PHP script. The teacher can access the results of the survey on the report page or export the results as a excel spreadsheet.
7. Results analysis	No	
8. Chat	Yes	PHP and AJAX methods. Chat can be added to the course page. The chat module contains a drop down list with all rooms the user has access to.
9. Forum	Yes	PHP and AJAX methods. Forums can be added to the course pages, and activity in the forums is sent to the user’s dashboard.
10. Wiki	Yes	PHP and AJAX methods. Wikis can be added to a course as a “wiki module” from the administration page. The wikis can then be edited by the course participants.
11. Messag.	Yes	PHP and AJAX methods. Built in messages system for communication between the users. Can also send and receive to outside email systems. Notifications are not sent to the messages system but instead to the user’s “dashboard” in their personal page.
12. CS****	No	

Table 9, Results for eFront

File manager

Upload file | Create folder

File type	File name	Size	Last modified	Share	Operations	Select
Folder	Digital Library		16 Jan 2010, 03:19		✎ ✖	
Folder	eFront Quiz1		02 Feb 2010, 23:05		✎ ✖	
Folder	wiki		06 Jan 2010, 00:44		✎ ✖	
Image	Bonampak_painting+contrast.jpg	122.74 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>
Image	ChacDresden.jpg	12.78 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>
Image	mayamap.jpg	39.08 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>
Image	Palenque_Relief.jpg	79.63 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>
Image	Palenque_Ruins.jpg	87.06 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>
Image	Topoxte.jpg	61.17 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>
Image	Maya_numbers.png	11.24 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>
Image	Spanish_Empire-World_Map.png	56.39 KB	03 Feb 2010, 03:50	🔒	📄 ⬇️ ✎ ✖	<input type="checkbox"/>

Figure 8: eFronts digital library

7.1.8 Sakai [34]

Sakai is described as an educational software platform release under a form of open source licensing called “educational community license. It is marketed especially for academic institutions and is Java based. Figure 9 shows a course page in Sakai when logged in as a student.

Sakai version 2.7.1		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	Java script. The teacher can add an assignment module to a course that has the attachment capability selected. The teacher can grade the submitted assignments.
2. PFS*	Yes	Java script. The user accounts have personal drop boxes where files can be stored. The files can be shared with other users by changing the access right to the file.
3. COR**	No	
4. Digital library	No	
5. Course evaluation***	Yes	Java script. No built in support for course evaluations but the test tool can be used to create an evaluation test.
6. Results page	yes	The results of the evaluation can be viewed on the results page for the test tool used to create the evaluation.
7. Results analysis	No	
8. Chat	Yes	Java script. The chat function is built in directly into the user interface and chat modules can be added to a course page or a project site. The chat conversations can be stored.
9. Forum	Yes	Java script. Forum modules can be added to course sites or project sites. The forums can also be used to send private messages to course participants.
10. Wiki	Yes	Java script. A wiki module can be added to the course site or project site. The wikis is very simple but includes the common wiki functions.
11. Messag.	No	
12. CS****	No	

Table 10, Results for Sakai

- [Resources](#)
- [Site Info](#)
- [Announcements](#)
- [Help](#)

Announcements

[Add](#)
[Merge](#)
[Options](#)
[Permissions](#)

Announcements

View

Viewing 1 - 2 of 2 items

Subject	From	For	Date	Remove?
Lecture Room Change	George O'Malley	site	Jun 10, 2008 1:12 pm	<input type="checkbox"/>
Reading for Tuesday's Lab	Meredith Grey	site	Jun 6, 2008 1:12 pm	<input type="checkbox"/>
DNA Polymorphism Exam on Thursday	Meredith Grey	site	Jun 4, 2008 10:00 am	<input type="checkbox"/>

Figure 9: Course page in Sakai

7.1.9 Ganesha[35]

Ganesha is described as an LMS that manages the learning process for the trainees and trainers and handles course administration. It is marketed to academic organizations and is written in JavaScript and with AJAX elements. Figure 10 shows the chat function in Ganesha which is launched as a separate window from the system. It is written in JavaScript with HTML frames.

Ganesha version 4.5		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	JavaScript. File upload drop boxes can be added to the course page and used to submit assignments.
2. PFS*	No	
3. COR**	No	
4. Digital library	No	
5. Course evaluation***	Yes	JavaScript. Does not have a built in tool that is dedicated to course evaluations but the test tools can be used to perform evaluations.
6. Results page	Yes	JavaScript. The results of the evaluations using a test tool can be accessed from a link on the test tool in the course page.
7. Results analysis	No	
8. Chat	Yes	Java Script in HTML frames. The chat module launches as a separate pop up window. The users that are currently online can be seen in the column to the right. Chat is only accessible from the main page of the system and can't be added to course pages and works more like a system wide chat.
9. Forum	Yes	JavaScript. The forums are only available on the main page of the system and cannot be added to individual course pages.
10. Wiki	No	
11. Messag.	Yes	JavaScript. Built in messages system for communication and notifications. The messages page consists of three tabs on for messages, one for notifications and one for sending new messages.
12. CS****	No	

Table 11, Results for Ganesha

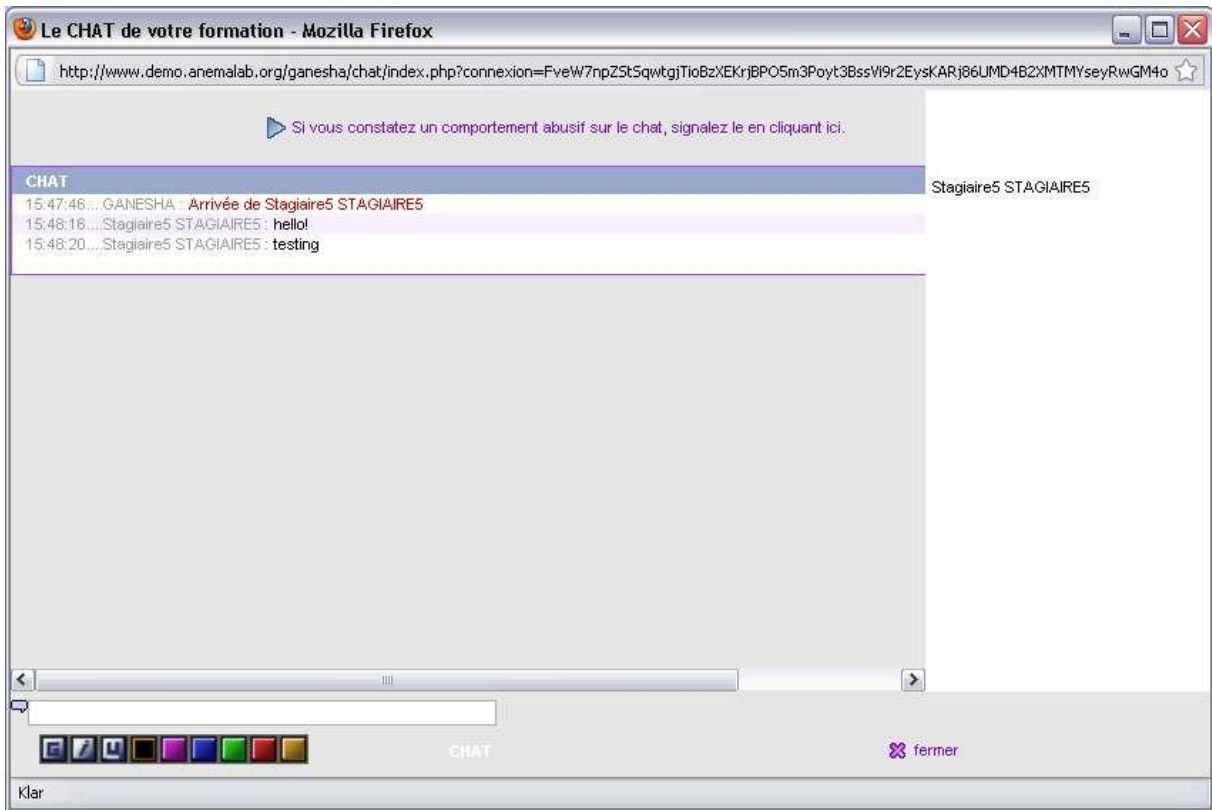


Figure 10: Ganeshas chat in an external window

7.1.10 dotLRN [36]

Originally developed by MIT and described as “the world's most widely adopted enterprise-class open source software for supporting e-learning and digital communities.” It is exclusively marketed to academic organizations and is written in Java and Built using openACS. It also uses JavaScript and AJAX methods. Figure 11 shows the course administration page which is used to administrate and edit the course page.

dotLRN version 2.5		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	JavaScript. Assignments can be uploaded to a “homework” module, which support versioning so that new versions can be uploaded without removing the old one. The teacher can comment on the uploaded file.
2. PFS*	Yes	JavaScript. The users can store personal files in their personal page. The files in the personal file storage can be shared with other users in the system.
3. COR**	No	
4. Digital library	No	
5. Course evaluation***	Yes	JavaScript. Have an assessment module dedicated specifically for course evaluations. It supports multiple types of questions and single question or entire evaluations can be reused or shared.
6. Results page	Yes	JavaScript. The results of the evaluations can be viewed from the results page or exported as a CSV file.
7. Results analysis	No	
8. Chat	Yes	JavaScript or AJAX methods. The chat windows launches as a separate pop up window. dotLRN have two chat functions one written in JavaScript and the other with AJAX methods.
9. Forum	Yes	JavaScript. Forums can be added to course pages or project group pages and activity notifications can be sent to the users email.
10. Wiki	Yes	JavaScript. The built in wiki function is based on the MediaWiki syntax. Also possible for the users to comment on individual wiki pages.
11. Messag.	No	
12. CS****	No	

Table 12, Results for dotLRN

[My Space](#) | [My Calendar](#) | [My Files](#) | [Control Panel](#)

Searching on the Internet ver. II: Overview

Overview

[All Views](#) | [Edit Metadata](#) | [All Resources](#)

Versions of this learning object:

Ver. #	Item Name:	Author:	Last Modified	Type:	
>> 1	itm00009	Jeremy Miller	2005-09-06 14:31:45	text/html	Make Live / Hide Everywhere

This Learning Object is in use in the following class instances:

Class Name	Subject Name	Term Name	Current	Set to	Views in this class
E-learning I	E-learning	All Year	1 of 1	1	Views

[Update Versions](#)

This files are in use in this learning object

[Add File](#) | [Clip This Resource](#)






Title	Versions	Type	
 TECH325_overview5.htm	1	Text - HTML	Clip
 style_TLcourses.css	1	Text - CSS	Clip
 TECH325_overview1.htm	1	Text - HTML	Main File Clip
 TECH325_overview2.htm	1	Text - HTML	Clip
 TECH325_overview3.htm	1	Text - HTML	Clip

Figure 11: dotLRNs course management page

7.2 Proprietary LMS systems

7.2.1 JoomlaLMS [37]

JoomlaLMS is a component to the Joomla content management system and described as a professional Learning Management System and SCORM E-learning software and is written in PHP and supports AJAX components. Figure 12 shows the collaboration systems in JoomlaLMS, which is launched as a separate window. To the left is chat, participants and video and voice of the teacher. To the right is a digital whiteboard. This collaboration system can be used for online lectures.

JoomlaLMS version 1.0.6 Free		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script. Assignment files can be uploaded by the students to assignment drop boxes that can be added to a course page.
2. PFS*	Yes	PHP script. Users can upload and store personal files on their user accounts and share the files with other users.
3. COR**	Yes	PHP script. Course objects can be reused or shared through the file library. Course objects in the file library can be added directly to a course.
4. Digital library	Yes	PHP script. Course files as well as other information and content can be shared to all users of the system, through a central learning objects repository that is comparable to a digital library.
5. Course evaluation***	Yes	PHP script. No built in dedicated tool for course evaluations but the systems survey and quiz tool can be used to create course evaluations.
6. Results page	Yes	PHP script. The results of the course evaluations can be viewed on the results page or exported in as CSV excel or PDF files.
7. Results analysis	No	
8. Chat	Yes	PHP script. The Chat function launches as a separate pop up window. Support for multiple chat rooms and group discussions. Chat sessions can be moderated by the teacher. Chat can be added to any course page or project rooms.
9. Forum	Yes	PHP script. Forums can be added to the courses or project rooms. Notifications on activity in a forum the user is a member of can be sent to the users email or as an RSS feed.
10. Wiki	Yes	PHP script. Wikis modules can be added to the course pages by a teacher or project room and used by the participants.
11. Messag.	Yes	PHP script. Built in messages system that is called email in the application. Messages can be sent either to individual users or groups. Messages can be forwarded to external email systems.

12. CS****	Yes	Built in using PHP script. JoomlaLMS has a built in collaboration system, with support for chat, video conferencing and virtual whiteboard. The system can be used for online classes or group meetings. The sessions can be archived.
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Table 13, Results for JoomlaLMS

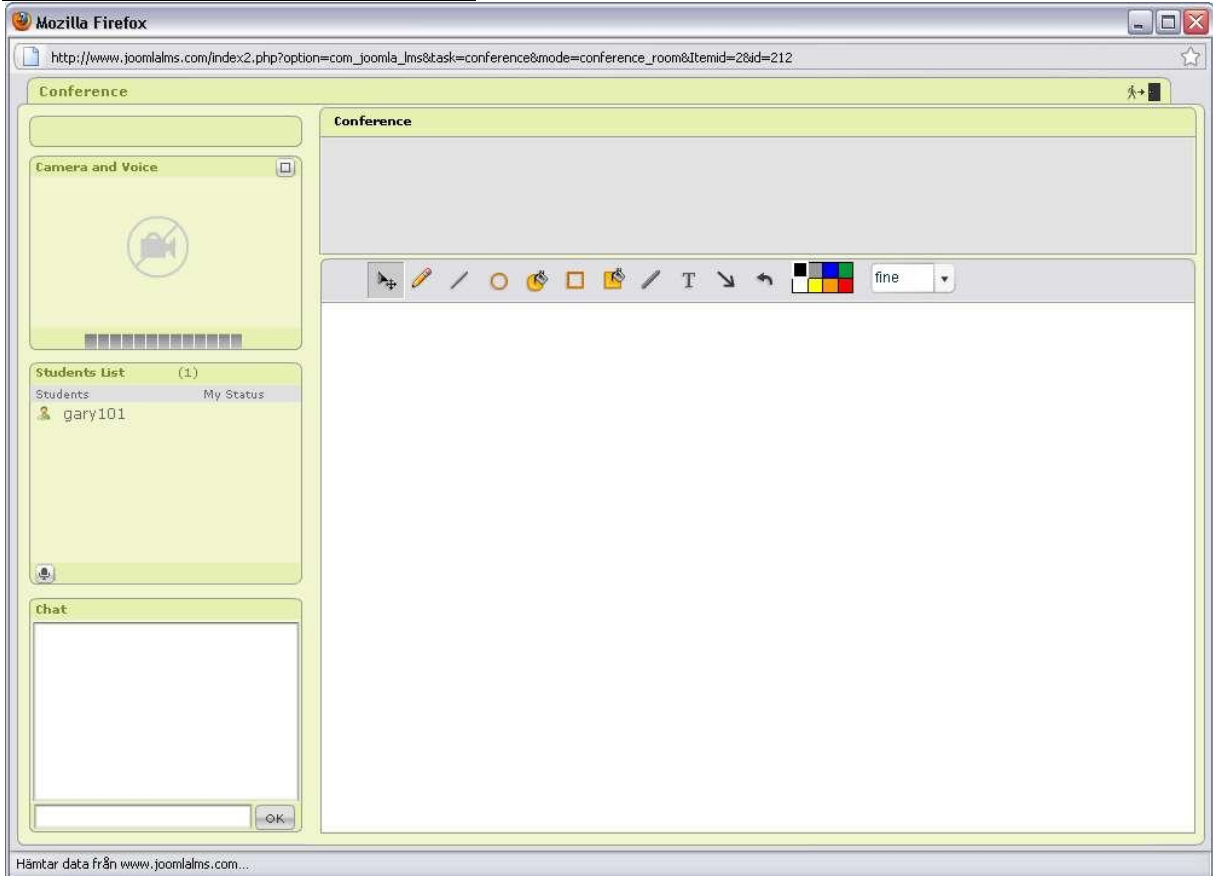


Figure 12: JoomlaLMS own collaboration system in an external window

7.2.2 Blackboard [38]

Blackboard is described as a “next generation” LMS. It is marketed to both academic and corporate environments and it is written in Java. Figure 13 shows Wimba collaboration system and figure 14 shows Webex collaboration systems. These are both third party systems integrated into Blackboard. They both launch in separate windows.

Blackboard Learn version 9.1		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	JavaScript. Students can submit assignments to drop boxes that can be added to any course page by the teacher.
2. PFS*	Yes	JavaScript. All users have access to private file storage using WebDAV (web-based Distributed Authoring and Versioning), a HTTP based protocol for collaborative file management and editing on web servers.
3. COR**	Yes	JavaScript. Course objects can be reused as well as course templates and stored in the course content Collections. Upload and download using WebDAV
4. Digital library	Yes	JavaScript. Have a built in digital library called “library collection”. The users can search for content and add their own. The course can link directly to content in the library collection. Also possible to connect the digital library to blackboard connection site, enabling sharing of content with other blackboard users.
5. Course evaluation***	Yes	JavaScript. Built in support for dedicated course evaluation tools with multiple types of questions.
6. Results page	Yes	JavaScript. Results from the surveys can be viewed on the results page.
7. Results analysis	Yes	JavaScript. Results page also allows for analysis of the results with varies graphs. Results can also be exported.
8. Chat	Yes	JavaScript. Built in chat tool that lets the students see who else is online. Support for chat groups and chat rooms. The chat logs can be archived.
9. Forum	Yes	JavaScript. Forums can be added to the course page. Built in spell-checker. The teacher can monitor the students’ activity in the forum.
10. Wiki	Yes	JavaScript. Wikis can be added to the courses or groups. The teacher can monitor the students’ participation.
11. Messag.	Yes	JavaScript. Blackboard have a built in messages system that supports messages lists. Messages can be forwarded to external email systems. Also supports archiving and attachments.
12. CS****	Yes	Support for Wimba (Figure 13) and Webex (Figure 14) collaboration systems as well as built in virtual whiteboard with chat support. The collaboration system launches as separate popup windows.

Table 14, Results for Blackboard

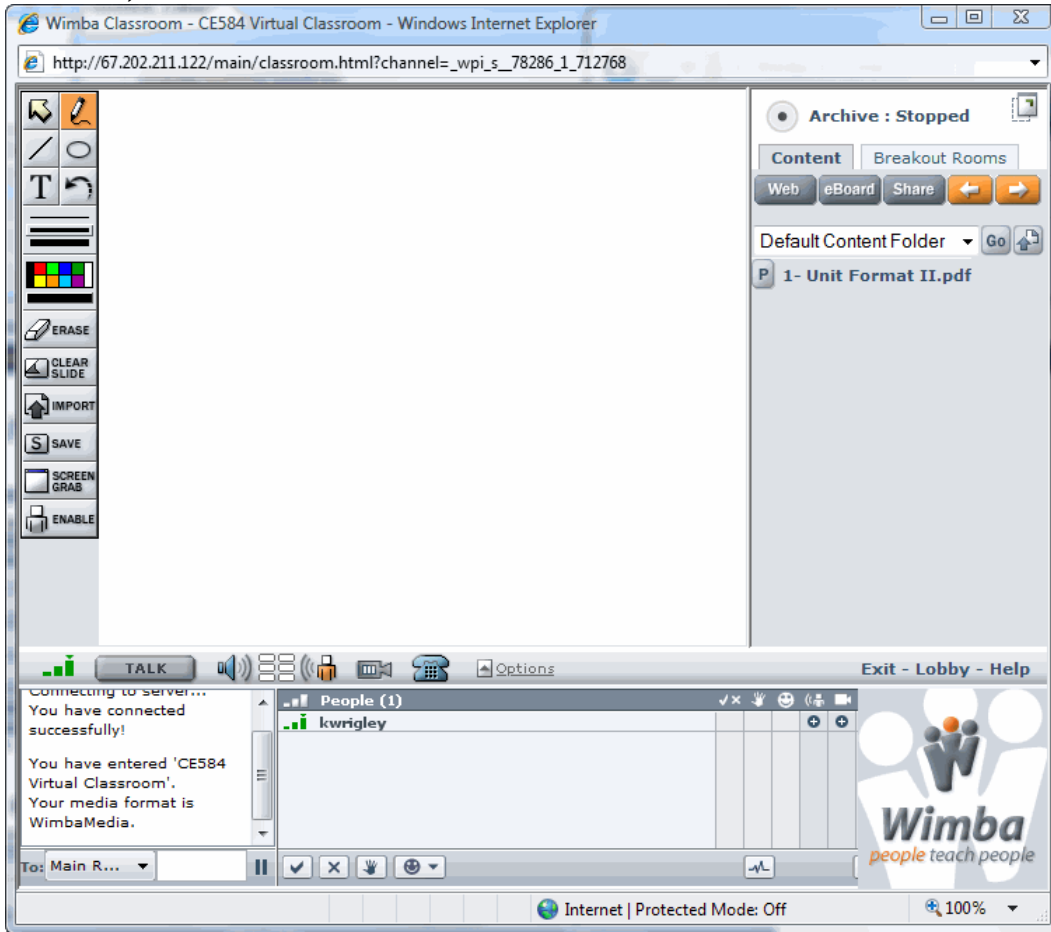


Figure 13: Wimba in an external window

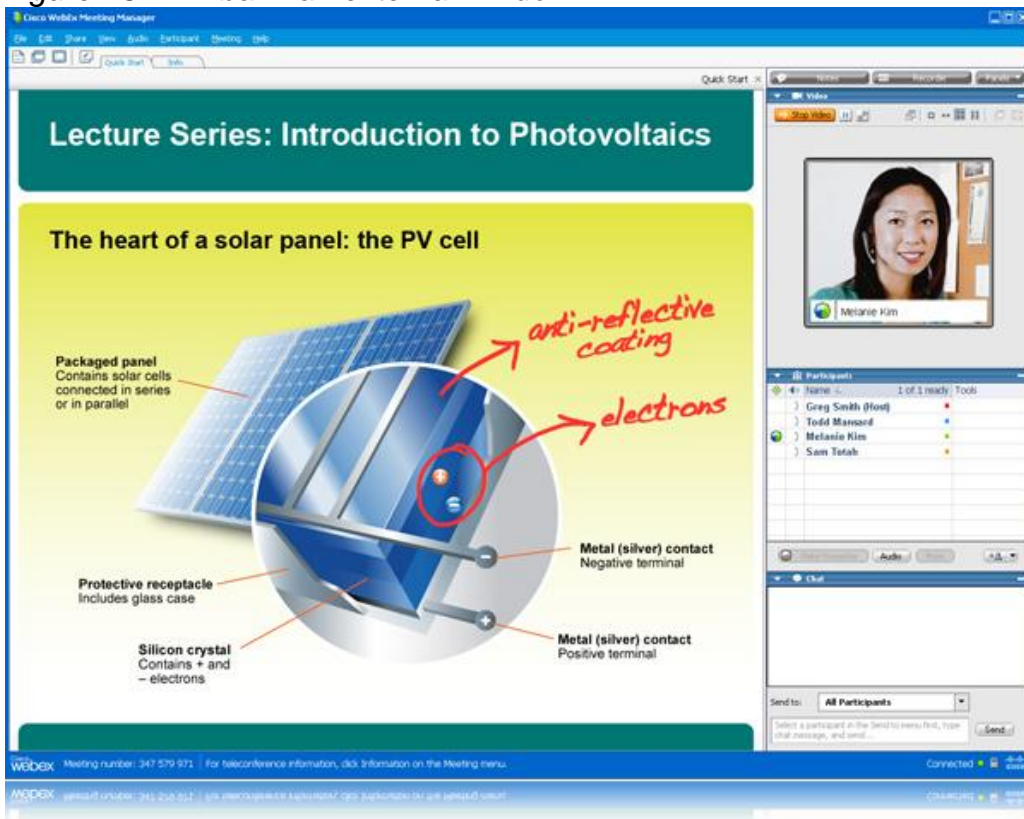


Figure 14: Webex in an external window

7.2.3 SharePoint LMS [39]

Share Point LMS is a Microsoft product and therefore other Microsoft product such as Office and active directory is highly integrated into the product. It is described as a fully functional LMS based on Microsoft office SharePoint server platform. It is marketed to both academic and corporate environments and is .Net based. Figure 15 shows the built in collaboration system that is launched as a separate window.

SharePoint LMS version 3.0		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	.Net code. Students can submit assignments files using course drop boxes that can be added to the course page.
2. PFS*	Yes	.Net code. Support for the users to upload personal files to file storages on their personal page. The file storage can be shared with other users.
3. COR**	Yes	.Net code. Support for sharing and reuse of course material. Possible for the teacher to set up a personal wiki with links to course content.
4. Digital library	Yes	.Net code. Built in digital library called “shared document library” that can be used to store an share course content and information.
5. Course evaluation***	Yes	.Net code. Support for dedicated course evaluation tools with multiple types of questions.
6. Results page	Yes	.Net code. The results from the evaluations can be viewed on a separate results page that is accessed from the course page.
7. Results analysis	Yes	.Net code. There are several tools available to analyze the results from the course evaluations.
8. Chat	Yes	.Net code. Built in chat that supports group chats and logging as well as notifications and MS outlook integration.
9. Forum	Yes	.Net code. Forums can be added to the course page. Supports notification and MS Outlook integration
10. Wiki	Yes	.Net code. Support for adding wikis to course and group pages.
11. Messag.	Yes	.Net code. Built in messages system that supports attachments and communication with outside email systems.
12. CS****	Yes	.Net code. Based on Microsoft Office communication tool 2007. Supports text chat, video conferencing, desktop and application sharing and session recording. Se figure 14.

Table 15, Results for SharePoint LMS



Figure 15: The collaboration system for SharePoint LMS in an external window

7.2.4 Meridian Global LMS [40, 82]

Meridian claims to be one of the biggest proprietary LMS systems and is described to have a:

“Proven Learning Management capability combined with fully integrated/inherent WEB 2.0 functionality to drive performance”.

It is marketed to both the academic and corporate arena and written in .NET.

Meridian Global LMS version 2011.2		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	.NET. The system supports assignment uploads for the students on the course page.
2. PFS*	Yes	.NET. Support for personal file storage and sharing of data between users.
3. COR**	Yes	.NET. Support for course object reuse sharing of course content objects and tools for collaborative development of material.
4. Digital library	Yes	.NET. Have a digital library called “knowledge repository” in the system that can be used to store and share course content objects and other information.
5. Course evaluation***	Yes	.NET Support for a built in dedicated course evaluation tool.
6. Results page	Yes	.NET Have a results page that can be accessed from the course page.
7. Results analysis	Yes	.NET. Results from evaluations can be analyzed directly in the interface or exported as Excel spreadsheet, PDF or XML files.
8. Chat	Yes	.NET. Support for instant messaging (chat) between the students and the teacher.
9. Forum	Yes	.NET. Support for threaded discussion forums that can be added to the course or group rooms.
10. Wiki	Yes	.NET. Support for wikis that can be added to the classroom or group rooms.
11. Messag.	Yes	.NET. Built in messages system with external email integration capabilities. Handles notifications in the system.
12. CS****	Yes	.NET. Built in collaboration system with support for virtual whiteboard, chat, video conferencing and collaborative document development.

Table 16, Results for Meridian

6.2.5. Hotchalk MyClasses [41]

Hotchalk is described as a “free learning management system automates daily teacher and student activities and provides a safe, secure, online environment for teachers, students and parents to interact.” It is one of the largest proprietary LMS systems and it is written in PHP. Hotchalk is exclusively marketed to the academic arena. Hotchalk is free to use but financed by advertisement. Figure 16 shows the course administration page.

Hotchalk MyClasses in 2010		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	PHP script. Course assignment upload can be created as a part of any course.
2. PFS*	Yes	PHP script. Support for upload of personal files and sharing with other users.
3. COR**	Yes	PHP script. Support for course content reuse and sharing through “MyLibrary”. Also supports a teacher only section of the program called “MyCommunity”, were teachers can collaborate on developing course material.
4. Digital library	Yes	PHP script. Hotchalk have a digital library called “MyLibrary” which support sharing of content and course objects between education centers, by having the system connect to a central system that allows for access to content created by other teachers. Hotchalk also contribute to the available material by creating course material and course plans.
5. Course evaluation***	Yes	PHP script. No dedicated course evaluation tools but the built in test tools can be used to create evaluation forms.
6. Results page	Yes	PHP script. Results from the evaluations can be viewed from the test results page.
7. Results analysis	No	
8. Chat	No	
9. Forum	Yes	PHP script. Support for discussion boards which is the same as forums.
10. Wiki	No	
11. Messag.	No	
12. CS****	No	

Table 17, Results for Hotchalk

The screenshot displays the HotChalk interface for course management. At the top, the HotChalk logo is visible, along with navigation tabs: MyDesk, My Classes (highlighted), MyLibrary, MyCommunity, NBC Video, Professional Dev, and Account | Help | Sign Out. Below the navigation, the breadcrumb path is Home > My Classes > Science.

The main content area is divided into several sections:

- Calendar Grade Book:** A table with columns for Lesson Plans, Media Resources, and Attached Files. The first row shows 'The Nature of Science' with media resources 'Bar graphs and picture graphs' and 'Graphing'. Below this, a list of activities is shown: Warm Up (Balloons, Bubbles, and Dry Ic..., Olympics), Lesson (Balloons, Bubbles, and Dry Ic...), Classwork, and Assignments (Balloons, Bubbles, and Dry Ic...).
- Notes for: Samantha Stevens (not joined yet):** A section for adding notes. It includes a 'Student Profile' with the name 'Samantha Stevens (not joined yet)', an 'Add a Note' section with fields for 'Assignment:' and 'Notes:', and a 'View All Notes' section showing a note titled 'Bar Graphs' with the text 'Samantha has made great progress with graphing.'
- The Nature of Science - the scientific method:** A detailed view of a lesson plan. It includes tabs for 'Warm Up', 'Lesson', 'Classwork', and 'Assignments'. The 'Description' field contains the text: 'Using the McGraw-Hill Lesson Plan on Bar Graphs, show examples of basic graphs.' The 'Starts' and 'Ends' dates are 06/23/2008 and 06/26/2008, respectively. The 'Goals & Assessments' field contains the text: 'Students should have a general grasp of bar graphs.' There is an 'Attach Files' section with a 'Browse...' button. Below this is a 'Resource Bucket' table:

Name	Source	Used in:
Bar graphs and picture graphs...	http://demo-lib.hotchalk.com/contents/5596	-
Graphing...	http://demo-lib.hotchalk.com/contents/8115	-

At the bottom of the resource bucket section, there is a 'Show:' dropdown menu with options 'this topic only' (selected) and 'all for this class', and an 'Add Resource' link. 'Close' and 'Save' buttons are located at the bottom right of the lesson plan window.

Figure 16: Hotchalks course management page

7.2.6 eCollege LearningStudio [42, 83]

eCollege is described as a “Software as a Service” (SaaS) LMS also known as software on demand. It is marketed exclusively to the academic arena and developed in Java and JavaScript. Figure 17 shows the built in collaboration tool which launches as a separate window.

Pearson eCollege LearningStudio version from 2010		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	JavaScript. Students can upload assignments to course drop boxes.
2. PFS*	Yes	JavaScript. The users can upload their own material and share it with other users.
3. COR**	Yes	JavaScript. Supports course object reuse and sharing of content with other teachers.
4. Digital library	Yes	JavaScript. Support for digital library called “central learning objects repository”, which allows the teachers and students to share content.
5. Course evaluation***	Yes	JavaScript. No dedicated evaluation tool but the testing tools can be used to create course evaluations.
6. Results page	Yes	JavaScript. Results can be viewed from the test results page.
7. Results analysis	No	
8. Chat	Yes	JavaScript. Chat can be added to course rooms and support group rooms, and archives discussions. Chat can also be monitored.
9. Forum	Yes	JavaScript. Support for forums. Can be added to courses and discussions can be archived. Student participation can be monitored and graded. Can also send notifications to external email systems.
10. Wiki	No	
11. Messag.	Yes	JavaScript. The system has built in messages system and can forward messages to external email systems. Supports notifications and searchable address book and attachments.
12. CS****	Yes	JavaScript. Built on collaboration tool which combines a virtual whiteboard with chat and VoIP communication. Sessions can be monitored and archived. It also supports application sharing.

. Table 18, Results for eCollege

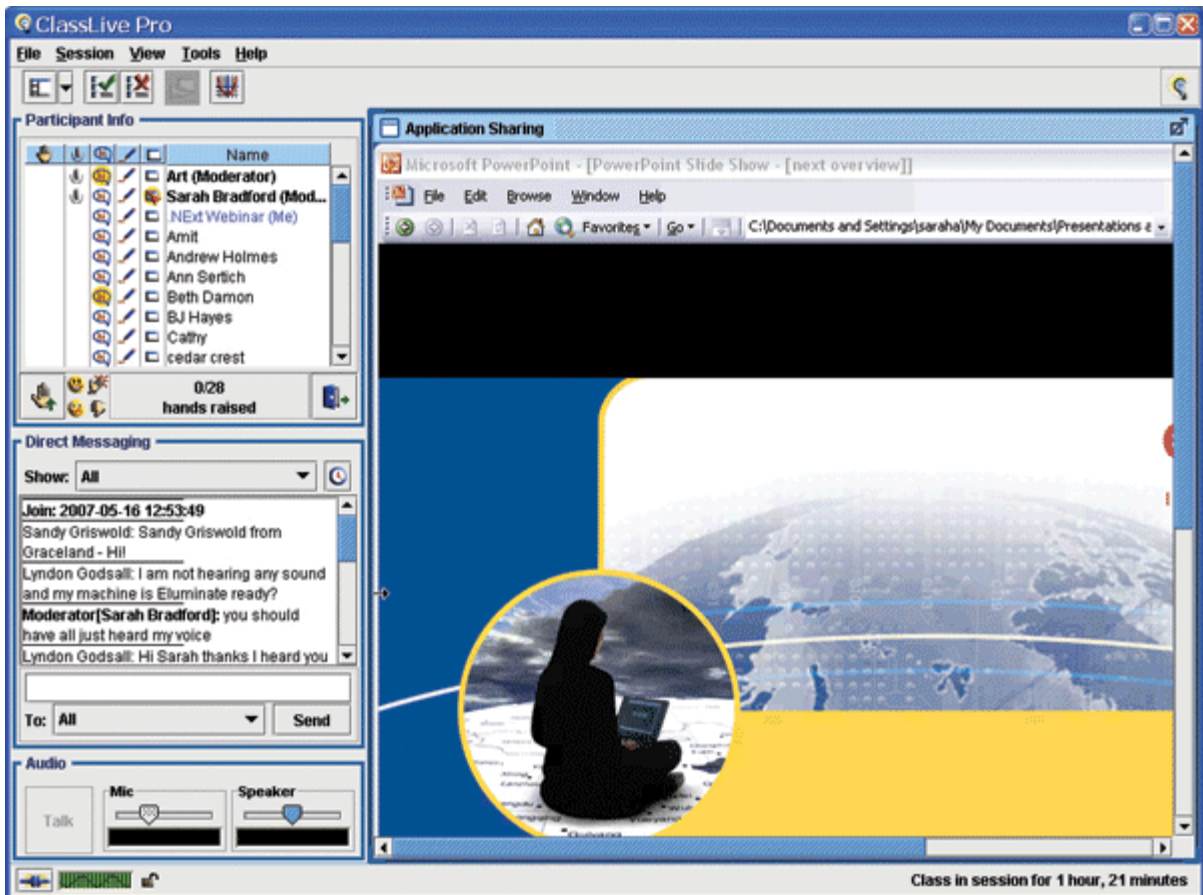


Figure 17: eCollege collaboration system in an external window

7.2.7 CCNet [43]

CCNet is described as a web-based course management and class communication tool. It is marketed to the academic arena and is written in Perl.

CCNet version 2010		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	Perl. Course assignments can be submitted to drop boxes in the course pages. The teacher can comment on the submitted files to give the student feedback. The teacher can also grade the files.
2. PFS*	No	
3. COR**	No	
4. Digital library	No	
5. Course evaluation***	Yes	Perl. No built in dedicated tool for course evaluations but the surveys tool can be used instead because it has similar functions to a course evaluation tool.
6. Results page	Yes	Perl. The results from the survey can be accessed from the results page that can be found on the course administration page.
7. Results analysis	No	
8. Chat	No	
9. Forum	Yes	Perl. Bulletin boards similar to forums can be created. Discussions can be exported to .CSV or text files. Allows anonymous posts and search of the discussions in the forum. Notifications on activity in the forums a user have access to can be sent to the students external email system.
10. Wiki	No	
11. Messag.	No	
12. CS****	No	

Table 19, results for CCNet

7.2.8 It's Learning [44]

It's Learning is described as an internet-based virtual learning environment that is made for all levels of education all around the world and it marketed to the academic arena and is written in ASP .NET with support for JavaScript AJAX functions. Figure 18 shows the digital library when accessed from the course administration page. Relevant objects can then be directly added to the course page. The digital library can also be accessed by the users.

It's Learning version 3.3		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	ASP .NET, AJAX. Course assignment can be uploaded to courses by adding a "file uploader" to the course. All uploads can be viewed by teacher on the course page. Support for group assignment uploads and status of the uploaded file.
2. PFS*	Yes	ASP .NET, AJAX. Users can upload material to their personal pages and then share it with others or submit it to the digital library.
3. COR**	Yes	ASP .NET, AJAX. Supports creating and reusing of course content objects and file sharing between teachers by submitting it to the digital library.
4. Digital library	Yes	ASP .NET, AJAX. Support for digital library called "my library" in the system. The digital library function is accessible to all users of the systems.
5. Course evaluation***	Yes	ASP .NET. No support for a dedicated course evaluation tool but the test tools can be used to create course evaluations.
6. Results page	Yes	ASP .NET. Results of the evaluations are available to the teacher on the test page in course page.
7. Results analysis	No	
8. Chat	No	
9. Forum	Yes	ASP .NET. Support for forums called "discussion tools" in the system and they can be added to the course page.
10. Wiki	No	
11. Messag.	Yes	ASP .NET. Built in messages system that can be integrated with external email systems.
12. CS****	Yes	ASP .NET. Built in collaboration systems with support for chat, video conferencing and virtual whiteboards.

Table 20, Results for It's Learning

The screenshot displays the 'it's Learning' digital library interface. At the top, the user is identified as 'Frank Beck' with a notification for 'Mail (2)'. The navigation bar includes links for 'Main page', 'Dashboard', 'Courses', 'Projects', 'Calendar', 'Messages', 'Mentor', 'ePortfolio', 'Library', 'My library', 'Search', and 'My s'. The breadcrumb trail indicates the user is in 'Home > Course > History > Add element to folder History > Explore'.

The left sidebar contains a 'History' section with links for 'Status and follow-up', 'Participants', 'Groups', 'Course settings', 'Trashcan', 'Links', and 'Planner'. Below this is a folder structure for 'History' including 'The Antiquity', 'The Medieval Ages', 'Early Modern Time', 'The Industrialisation', 'The World Wars', and 'Add'.

The main content area features a search bar with the query 'napoleon'. Below the search bar is a table of results:

Title	Author	Library
Napoleon Bonaparte, part 1	Frank Beck	Personal

At the bottom of the page, there are navigation links for 'Previous', 'Next', and a page indicator '1'. On the right, there is a 'Show' dropdown menu with options for 10, 25, 50, and 100 items.

Figure 18: It's Learning's digital library

7.2.9 edu2.0

Edu2.0 is described as a free cloud hosted web based only LMS with social community features. It is market to the academic arena and it is developed in Java and JavaScript. It is the only system in the survey developed in Sweden. Figure 19 shows the chat function in an external window.

edu2.0 version 2010		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	JavaScript. Assignments can be uploaded to the course page and the teacher can comment on and grade the submitted files.
2. PFS*	Yes	JavaScript. All users can upload personal files to the "locker" on the personal page.
3. COR**	Yes	JavaScript. Support for reuse of course content and sharing of course objects between the teachers using the digital library.
4. Digital library	Yes	JavaScript. Built in support for digital library which enables the users to share material with all users of the system. This makes it possible to create courses for all members not just the students in the school.
5. Course evaluation***	Yes	JavaScript. Course evaluations can be performed with the integrated survey tool. Free from and multiple choice questions are supported.
6. Results page	Yes	JavaScript. The results of the survey can be accessed by the teacher from the grading area of course page.
7. Results analysis	No	
8. Chat	yes	JavaScript. Chat rooms can be added to course or group rooms. The chat sessions can be saved a transcript of the discussion. Chat launches as a separate window from the system.
9. Forum	Yes	JavaScript. Forums can be added to course or group rooms.
10. Wiki	yes	JavaScript. Wikis can be added to course or group pages.
11. Messag.	Yes	JavaScript. Built in messages system that can be integrated with external mail systems.
12. CS****		

Table 21, Results for edu2.0

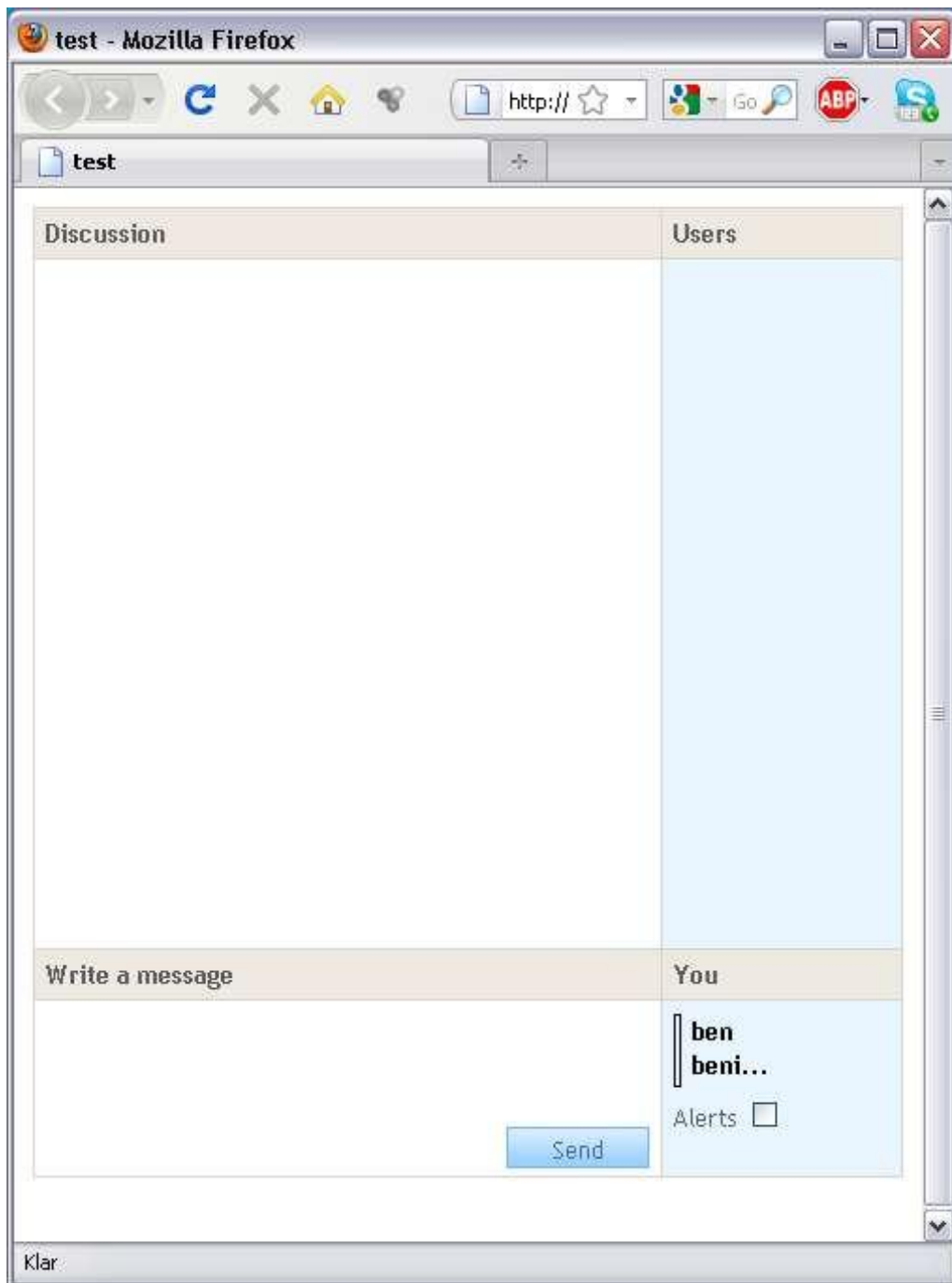


Figure 19: edu2.0 chat in an external window

7.2.10 Desire2Learn version 8.4.2 [46, 83]

Desire2Learn is described as “*Suite for Higher Education makes it easy to help design, launch, and expand successful online programs.*” It is marketed to both the corporate and academic arena and it is written in Java and C#. Figure 20 shows the course builder page which is used to setup courses.

Desire2Learn version 8.4.2		
Requirement	Supported	Technology used
1. Assign. Upload	Yes	JavaScript. Drop boxes can be added for course assignment uploads. The teacher can comment and grade submitted files.
2. PFS*	Yes	JavaScript. All users have access to personal file storage which they use to upload files and shar them with other users.
3. COR**	Yes	JavaScript. Support for course object reuse and sharing of course object with other teachers.
4. Digital library	Yes	JavaScript. Have support for digital library called “learning repository” in the system, were users have share content.
5. Course evaluation***	Yes	JavaScript. Built in survey tool to support course evaluations.
6. Results page	Yes	JavaScript. The results of the survey can be viewed on the results page. There result can also be shared or exported.
7. Results analysis	Yes	JavaScript. Contains several tool to analyze the results of the surveys.
8. Chat	Yes	JavaScript, AJAX. Built in chat system that can be added to course group rooms. Chat logs can be archived. There is also a smaller IM tool called pager that can be used to send messages to users in the contact list.
9. Forum	Yes	JavaScript. Forums can be added to course pages or group rooms. Support archiving conversations that can also be shared or used in other courses. Discussions can be monitored for student participation and used for grading.
10. Wiki	Yes	JavaScript. Wikis can be added to the class or group rooms
11. Messag.	Yes	JavaScript. Built in messages system with support for lists and searchable address book. Can also be integrated with external email systems.
12. CS****	Yes	JavaScript. Built in collaboration tool called “LiveRoom” which supports virtual whiteboard, chat, application desktop sharing and voice chat.

Table 22, results for Desire2Learn

Toolbox

Build Structure

Drag or click modules and placeholders to build your structure

Create Objects

Drag or click objects to create new content and fill in placeholders

Browse Objects

- Course Files: View, upload and add files
- Discussions: View and Add Discussion Topics
- Dropboxes: View and Add Dropboxes
- Quizzes: View and Add Quizzes
- Grade Items: View and Add Grade Items

Course Builder Canvas

- Advanced Chemical Sciences
- Advanced Chemical Sciences, An Introduction
 - Introduction
 - Expectations
 - Module Discussion Area: Drag a discussion here
- Ch 1: The Principles
 - Definition
 - Atomic Theory of Matter
 - Discovery of Nucleus – Complex Mapping
 - Chapter 1 Assignment: Drag a dropbox here
 - Link to Chapter 1 Quiz: Apr 1, 2010 – Apr 3, 2010
 - Additional Review Material: Drag a file here

Figure 20: Desire2Learns course builder page

7.3. Summary of results

The below table (table 23) is a summary of the results from the survey and will highlight the most commonly supported requirements among the LMS systems in the survey.

The top row is the requirements specified in “*Design of survey*”. And the left column is the name of the LMS system.

	1. Assign. Upload	2. PFS*	3. COR**	4. Digital Library	5. Course evaluation ***	6. Results page	7. Results Analysis	8. Chat	9. Forum	10. Wiki	11. Messages	12. CS****
Open source												
<u>moodle</u>	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
OLAT	✓	✓			✓	✓		✓	✓	✓		
<u>Claroline</u>	✓				✓	✓		✓	✓	✓		
<u>Docedo</u>	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓
Dokeos	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
ILIAS	✓		✓		✓	✓	✓	✓	✓	✓	✓	
eFront	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
sakai	✓	✓			✓	✓		✓	✓	✓		
Ganesha	✓				✓	✓		✓	✓		✓	
.LRN	✓	✓			✓	✓		✓	✓	✓		
Proprietary												
JoomlaLMS	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Blackboard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Share Point LMS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Meridian	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hotchalk	✓	✓	✓	✓	✓	✓			✓			
eCollege	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓
CCNet	✓				✓	✓			✓			
its Learning	✓	✓	✓	✓	✓	✓			✓		✓	✓
edu2.0	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Desire2L	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 23

* Personal file storage

** Course Object Reuse

*** Course evaluation capacity

**** Collaboration System

8. Analysis of results

The first part of the analysis presents the most complete LMS systems with regards to the number of requirements supported and an analysis of the differences between LMS systems using either open source or proprietary licensing. The second part is an analysis of the support for each requirement in the survey as well as examples of implementations and use in the LMS systems.

8.1 The most complete LMS systems

The LMS systems that support the largest number of requirements among the open source systems are Moodle, eFront, docebo and Dokeos. The system on the proprietary side is JoomlaLMS, blackboard, SharePointLMS, Meridian and Desire2Learn. These eight systems fulfill almost all of the requirements for the survey. Over all the proprietary LMS systems had a small advantage over the open source systems in the number of requirements fulfilled.

8.2 Difference between open source and proprietary licenses

There were some significant differences between the LMS systems using open source licensing versus proprietary. The biggest difference was the type of service provided by the organization developing the system. None of the open source system provided hosting or “software as a service”. The only option available for any potential customer is to download and install the software on their own servers. The proprietary systems on the other hand, had many different purchasing models available and for example It’s learning and edu2.0 only offer their software as an online service.

Another difference between the two licensing models is that it was significantly easier to establish the requirements for the open source systems because the home pages offered a more comprehensive list of available features and more complete documentation of user manuals and specifications. Moodle, OLAT and Claroline also had fully working demonstration sites setup up, to allow potential customers to try the system. None of the proprietary systems offered similar demonstrations for free.

8.3 Supported requirements

8.3.1 Course content management

Assignment upload

This requirement is supported by every LMS system in the survey. However the difference in how the system handled the submitted assignments varied. A notable feature is the support for comments and grading of the submitted assignments by the teacher. Moodle, Olat, CCNet and edu2.0 supported this. This feature allows the teacher to give the student feedback on the assignment directly.

Personal file storage

This requirement is supported by all systems except for Claroline, Ganesha and CCNet. This requirement is not important for the course work but it can be practical for the users to store files on the system. Systems such as Moodle and SharePointLMS have support for file sharing, which enables the users to upload files to their personal file storage and then share them with the other users or by submitting them to a file repository. The systems OLAT and Dokeos allows user to submit assignment files to the course drop box from the personal file storage or by changing the ownership settings for the file.

Course object reuse

This requirement is supported by fourteen out of twenty systems and enables the teachers to share parts of the courses with other teachers and to assemble a course from available course content objects in the repository of the system. The implementation of this requirement is similar between the systems. The teacher can upload information and use it in a course or share it with the other teachers through a repository. The system that supports digital libraries also allows the teacher to use information from the digital library when creating the courses.

Digital library

This requirement has the biggest difference in support between open source and proprietary systems. Only eFront supports it whereas all the proprietary systems support it except for CCNet. The difference between the file sharing in course object reuse is that digital libraries is for all information and available to all users. It is also system wide and in case of blackboard and Hotchalk the digital library can be connected with other implementations of the system through a central server.

8.3.2 Evaluation

Evaluation

All system supports this function because of the importance of getting feedback from the students about the courses. The only difference is that some systems such as OLAT, Claroline JoomlaLMS and Hotchalk had no dedicated course evaluation functions built into the system. However course evaluations can be performed using the systems built in test functions, a function that is supported by all systems. Some systems also provide support for standardized evaluation forms such as Moodle

Result page

All systems support this function for obvious reasons and there is little difference in the implementation of this requirement. The results can be accessed from the course administration page linked from the name of the evaluation. In all systems there is also a way to export the results in some kind of file format such as .CSV, PDF or excel spreadsheet.

Result analysis

This support for analysis of the evaluation results within the application had the lowest number of systems supporting it. Only seven systems fulfilled this requirement. The analysis of the results is usually performed by providing different ways to display the data in graphs. Systems that support standardized evaluation forms also support the analysis methods of these standards.

8.3.3 Communication

Chat

The word chat is used instead of instant messaging (IM) in this section because the most common description of IM [59] (page 364-365) is too narrow to describe the text-based synchronous communication systems used in LMS programs.

The use of chat programs as a part of an LMS system is common. Seventeen out of twenty LMS systems in the survey had some form of built in chat, either built in directly into the user interface or as a separate popup window. The only LMS systems without chat were Hotchalk, CCNet and it'slearning.

Chat is used for synchronous communication with the teachers and students and it can also be used between the students to help each other or support project work [59].

Other uses [60] (page 4 & 5) of chat is to function as a form of notification system within the LMS, that gives the user updates on the course and feedback on the users. SharePointLMS for example uses the chat as a notification system.

The notification system can also work as a presence tool [60] (page 5) within an LMS system by showing who is online and using the chat. Blackboard has this function.

The three systems that did not support chat were Hotchalk, CCNet and it'slearning. Hotchalk, these did not include any chat function because their developers argue that their systems is focused on the quality of the courses and not so much on the communication between the students and the teacher. CCNet did not include any chat and it was the system in the survey that supported the lowest number of requirements. But the focus for CCNet according to the developer is to provide a simple stable and fast LMS with strong focus on the course management rather than experimenting with features that are not essential to e-learning courses. Although it'slearning did not have a built in chat function that function is supported by the conferencing tool. More extensive chat systems is planned to be added in later releases of the system.

Forum

Forums are supported by all systems. Forums are one of the most basic and early forms of asynchronous communication over the internet. It is very easy to implement and eCollege and Desire2Learn have the ability for the teacher to monitor activity in discussions and use that as a base for grading. Other systems such as OLAT also have the ability to archive the discussion and share it. In Docebo archived conversions can be exported as .CSV files. With few exceptions the forums can be added to the individual course pages of the systems or added to project groups. None of the systems supported forums for topics unrelated to the courses. There were a number of different functions available; such as the ability to view the discussion in different formats, archive discussions and monitor discussions.

Wiki

In a wiki website the users can edit and contribute with their own material. The editing and submission functions are often open but can also be moderated by the owner of the wiki. A wiki can either be public or protected with passwords so only the members can access it. The most famous wiki is Wikipedia.org. [62] [66] According to the developers of the wiki concept a wiki is:

“a wiki is a freely expandable collection of interlinked webpages, a hypertext system for storing and modifying information – a database, where each page is easily edited by any user with a forms-capable Web browser client” [64]

Wikis is simple to integrate and there are a lot of different solutions available to use, they are also simple to build directly into the system regardless of what language the LMS is written in. The wikis that were found in the survey is often very simple and only includes the basic features of a wiki. Some notable exceptions are Blackboard which allows the teacher to monitor the individual student’s contribution and Moodle which supports archiving of wikis.

According to [62] the wikis can in an LMS be used by the teacher to post course notes and let the students contribute. The students can also submit their own notes and comments with references to other sources. Wikis can also be used to support the student’s project work and for brainstorming sessions [62].

Other uses for wikis in LMS systems can be to support the teachers in developing course material by sharing the ideas on a wiki and let other teachers comment and contribute to them [63].

Messages systems

The survey indicates that having built in messages system within the application is relatively common. The primary function of the messages systems used by all of the LMS systems in the survey was to handle the internal asynchronous communication within the system between the users. However there was a lot of different additional functionality available. For example Moodle, ILIAS used the messages system to handle notifications from the courses and activity in the communication features such as forums. Another common feature was the ability to integrate the internal messages system with external mail systems. Either by allowing the messages system to forward messages to external email systems (eFront, Blackboard, eCollege) or by integrating the external mail systems and handle email sent from the outside. Systems that support this integration is Moodle, eFront, SharePointLMS and Meridian

Collaboration system

Collaboration systems is programs that lets a number people collaborate on a project through an interface consisting of several communication systems such as chat, VoIP and voice and video chat combined with some form of [47] [48]

Collaboration systems are a different branch of systems to support online teaching and collaboration but they are often integrated into LMS systems. The most common features of collaboration systems are: text based chat, VoIP, video conferencing (in education the teacher can be the only one using a webcam to talk to the students), some kind of collaboration interface, which can be a document everyone can edit at the same time or a digital whiteboard and application sharing [50].

Half of the systems in the survey supported this requirement, making it the least supported requirement in the communication category.

Collaboration systems can be used in two different ways; integrated into the systems interface (Dokeos, Meridian) or launched from the system as a separate window (Moodle, JoomlaLMS, Blackboard, SharePointLMS). Moodle and blackboard uses a heavily integrated version of the third party collaboration systems Wimba [49] and webex [91]. The integration gives Moodle the ability to archive the sessions and scheduled session in the calendar function. SharePointLMS integrates Microsoft office communication tool 2007 which supports desktop and application sharing.

9. Discussion

The first part of the discussion is about the requirements and the difference between the academic LMS systems and the corporate training LMS systems. After that is a discussion about the difference between LMS systems using either open source or proprietary software licensing. The second part of the discussion is about the main question for the thesis and the technologies that were identified are discussed in detail.

The three most recommended categories of requirements in the literature review were course content management, evaluation and communication. The reason for this is that course content management represents the most basic functionality of an LMS system, the ability to handle courses, course content objects, student submissions and other related material. Evaluation is important for the analysis of the student's view of the courses, information that is useful to further develop the courses and improve the overall results of the e-learning program. Communication is important for improving communication between students and teachers and is the most effective method to make students feel more involved with the course work.

Another notable finding in the literature review is that category for pedagogy and learning process is the least recommended one. The reason for this is primarily that pedagogy is largely ignored by the developers of LMS systems. Functions and features are prioritized, not how they should be effectively used in the courses. This means that the studies of the effectiveness of LMS systems focus more on evaluating the results of implemented technologies rather than developing technology to support existing pedagogical theories [89, 90(page 17-20)].

The literature review established the requirements for an LMS system used in an academic environment. The requirements for an LMS system suitable for a corporate training environment were separated. This showed that there is a significant difference between the requirements for an LMS system depending on which market it is developed for. The requirements established for the academic environment are not exclusive to the academic systems but serve as the basic functions [14] for an LMS system. When developing LMS systems for the corporate training environment the developers need to implement functions and features corresponding to these basic requirements and also the additional requirements needed for a corporate training environment such as more advanced integration options and a higher focus on security and availability [19]. Because LMS systems that have been developed for and are marketed to the corporate environment have to support the basic requirements it can also be used for academic e-learning courses.

The reason for separating open source and proprietary LMS systems in the survey was to highlight if there were any difference between the two forms of software licensing. The biggest difference found were the services offered from the different organizations developing the LMS systems. None of the open source LMS providers offered any advanced services for their product other than various support plans. For example none of the open source systems offered hosting services for their system. Instead they only provided download of the software from their websites. The developers of the proprietary LMS systems on the other hand offered a number of different services. Examples of the different options were: multiple package

solutions of the software depending on organizational needs, hosting of the LMS system on their servers, centralized digital libraries and prefabricated courses. Two of the proprietary systems only offered their system as an online service. These were it's learning and edu2.0, and the reason for doing this was that their LMS systems had additional functions commonly found in social community websites. The benefits to the customer for using this model is the low costs to get started, the downside is the limited ability to modify the system.

The advantages for the open source systems are that the administrators has complete access to the systems source code and can modify it to better suit their current organization. Other advantages are that the software is free of charge and the simplicity to find information about the system. The disadvantages of the open source systems is that there is seldom any ability to purchase support plans and the need to provide server space for the system which can increase the start up costs if new hardware needs to be bought. The advantages of proprietary LMS systems are that they often have several different purchasing plans available, which makes it possible to select the best suited option for the organization. This can lower the cost of acquiring the system. Another benefit is that there is often a support plan available. The disadvantages are the often limited access to the source code and the potentially higher costs to expand the number of users on the system. During the survey it became apparent that the information about the systems from developers was better and easier to find from the open source then from the proprietary developers. It was not possible to determine the reason for this with the survey; although suggestively the proprietary developer gives more detailed information to their potential customers then they have on their website. The open source providers do not sell their systems to customers in the same way and must instead provide more detailed information directly to anyone visiting their site.

Where there any differences in the support for the requirements between the open source and proprietary LMS systems? The analysis of the results from the survey revealed that the proprietary systems implemented slightly more requirements then the open source systems. The explanation for this was not a part of the survey. Suggestively the open source systems focus more on the basic requirements [14] and the academic market, whereas the proprietary systems focus more on corporate market, were having more features can be used a selling point. Also the difference in the development strategy can have an effect on the number of requirements, because open source developers have a more open development process based largely on contributions from independent programmers volunteering to work for free. The proprietary developers on the other hand hire programmers for their development team, which makes it easier to centralize the development and decide specific requirements that need to be implemented.

How can new technology be used to improve the outcome of e-learning courses using LMS systems? The survey showed that there are a number of different ways to implement the requirements established by the literature review. It also showed which requirements that were the most commonly used within each category.

How are the LMS systems implementing the requirements in the course content management category? The first category in the survey was course content management (CCM) because the requirements in this category are the most basic functions needed for an LMS system and the functions that are absolutely necessary [14]. The goal for an LMS system however should be to make it as easy as possible to use and only include features that are necessary or requested. For example all systems supported upload of course assignments. The benefits of allowing the system to handle course assignments are self evident. It is also a relatively easy function to implement. The support for personal file storage is extensive. For example the files uploaded to the personal file storage can be shared with other users if the system has built in support for file sharing. It can also be used to store finished assignment before being submitted to the course drop box. The support for personal file storage is not necessary for the outcome of the courses but they can add value to the system and they are often a connected to the course object reuse and digital library if those requirements are implemented into a system.

There are a high number of LMS systems that implements the course object reuse requirement and it can provide a number of useful functions. For example a simple way to share already created course content objects. This provides an easy way for the teachers to add content objects to the course as well as discuss how to improve the individual objects. The ability to easily assemble courses with shared course content objects can speed up the process of creating courses and centralize the storage of course information.

An extension of the implementation of the course object reuse requirement is the digital library. The number of systems with digital libraries was few and only one open source system supported this. The reason why there is only one open source system that supports the digital library function is mainly the cost for the developers to provide server capacity to facilitate the connections between the different installations of the system and the central database. The purpose of digital libraries in LMS systems is to allow the different organizations that use the system to share information and for the developer to provide access to other sources of information and were provided; their own course content. A few of the proprietary systems developers have business plans that include in house development and sales of premade courses.

How are the LMS systems implementing the requirements in the evaluation category? The second most heavily supported category of requirements is the evaluation related requirements. Especially the capacity for the system to provide feedback from the students through course evaluation functions. The major difference between the systems in this category is if the systems have a tool specifically dedicated to course evaluations or if the tools designed for tests and quizzes was used instead. The ability to evaluate the feedback given from the students about the course is crucial to be able to further develop the course. It is therefore a necessary tool although dedicated tools for this are not necessary. This requirement is very important because it lets the teachers be aware of what the students think about the course. This information can be used to further improve and develop the course. It is therefore an indispensable function for any LMS system. Evaluation is also important for the corporate training LMS systems, were they are used to evaluate the return of investment for the system.

Requirements related to the evaluation are if the system has a dedicated results page or the ability to evaluate the results. Dedicated results page is supported by all systems in almost the same way; even the systems that had no dedicated evaluation tool still had a results page for the test tool that can be used to view the results. Results analysis on the other hand had a lot fewer systems supporting it. The reason for lack of support for this requirement is that it is not necessary and it takes a lot of time to implement and because all systems allows for export of the results, the analysis can be performed externally with more powerful programs. This function can be of interest for the corporate LMS customers because it can help them to assess the return of investment of the system, because the cost efficiency of the courses is important for the organization [13].

How are the LMS systems implementing the requirements in the communication category? The third and last category is communication and the requirements in this category have the most effect on the outcome of e-learning courses [3].

There are a number of different technologies that can be used to support communication in an LMS system. The technologies in the thesis are chat, wikis, forums, messages systems and collaboration systems. The findings of [61] suggest that the use of chat in e-learning may improve the participation of the students in the courses.

The survey showed that chat is a very common feature in LMS systems and almost all of the systems in the survey supported text based chat. This is most likely because chat is the easiest of the communication requirements to implement and that it have many positive effects for the outcome of the courses. The chat tool does not even have to be integrated into the LMS as a study using WebCT (now blackboard) and AOL IM [59] together. It showed that simply giving the students the same standalone IM client and a list of the students to use for communicating during their work improved the student's social behavior. In a concluding remark:

“Students appreciate having a nonmonitored space in which to communicate, and the implementation of IM services can provide students with a much stronger sense of community and belonging when they greet each other in the “virtual hallway.” [59]

Chat programs have also shown that even the simplest use of them during an e-learning program can make the students feel more involved with the course and the other students and also improve their participation in the course [59] [61].

There were three LMS systems that did not support chat, and the reasons given for this was that for one of the systems a chat function was planned to be implemented in a future release. Another argued that the focus for their system was simplicity and stability and that they therefore had not included chat. It was also argued that the focus of their systems was to focus on the quality of the courses and not let any “unnecessary” communication technology interfere with the learning process.

The reason to not include chat because of the focus of their system is the quality of the courses is disproved by both the results of the literature review and the survey. Chat is a simple and effective way of improving the results of e-learning courses. Also the outcome of the classes is not depending on the courses themselves but also on how the students can communicate and interact with each other.

However there are concerns for how chat should be used in LMS courses because in order to effectively use chat in an LMS system the rules for how they should be used is important.

For the second technology in the communication category forums the support amongst the systems was complete, all systems supported forums although in some cases they very referred to as messages boards. The reason for this is that it is the most basic of all asynchronous communication systems and the oldest one as well. It is the internet communication technology most people have come in contact with. This means that the technology is proven, well-known and that there is a lot of information and experience on how to use it. Forums are simple and effect tool to support asynchronous communication in LMS systems.

Why is the use of wikis common? The third technology in the communication category is wikis and they are a very common feature in LMS systems because they are easy to implement [62]. Wikis can also serve as a repository for knowledge and to promote collaboration between the students, teachers and staff [63]. According to [64] wikis can provide an efficient, flexible and user friendly collaboration system, that supports student interaction, knowledge creations and archiving. The user friendly nature of wikis also makes them attractive to the students and has the effect that students can focus on the content rather on the technical process of writing [64]. The teachers should promote collaboration rather than competition in relation to wiki activities. Student should also be encouraged to contribute to the wikis when they come across something useful not just work with it during the course. The usage of the wiki should also be an integrated part of the course and the teachers should act as moderators rather than instructors and promote the free development of content to embody the nature of wikis [65].

A study at a University in Australia [66] showed that the use of wikis in e-learning successfully enabled hundreds of students to participate in a collaborative exercise, it also showed that e-learning systems can use wiki technology to enhance social interaction.

The wikis in the LMS systems were used in a similar way to the forums mentioned above. It also supported many of the functions available to the forums. The implementation of the wikis in the LMS systems in the survey was simple and they did not have a lot of functions. However this is not important because of the way wikis are supposed to be used. It is a simple an effective way to collaborate on the development of information for the courses.

What can an internal messages system contribute with? An effective way of managing internal communication and notifications within an LMS system is by using a messages system, it have many similarities to email, which is a very basic form of communication over the internet and it is also a source of problems such as spam. Message systems are not easy to implement although they are a common feature amongst the systems in the survey suggesting it is a requested and effective feature for an LMS system.

The most common way messages systems work is as a dedicated messages system separated from the outside based on the findings in the survey. It also showed that built in messages systems are a common way to solve basic communication issues within the LMS systems such as notifications. Some systems in the survey also had the ability to integrate external email system to the built in messages system. However this may not be a good idea because it can cause the messages system to be filled with unrelated messages and decrease the efficiency of the communication in the system.

Therefore the best approach to messages within LMS systems is to have it strictly focused with managing course related communication and that the only outside email connection is the ability to forward messages to outside mail accounts should the user decide to do that, mainly because of the widespread use of email among the students.

Why are collaboration systems not common within LMS systems? The last technology in the communication category is collaboration systems and it was also the least common technology. This is likely because of three reasons, the first is that they are more complicated to develop and integrate into the system. The second is that they have not been available for as long as the other technologies, which means that there is less experience and understanding for how they should be used. The third is that they require more hardware and broadband connectivity to be used effectively [51]. However these programs have the ability to make students feel more involved when using an LMS system. Because of this they can reduce the number of drop outs in a course [50]. Another positive effect of these systems is that they can make the student feel excited about the course using the new technology. As noted by [51] in their conclusion.

Although the students are positive towards using the new technology it is also important that the teachers and the organization behind them are aware of the new challenges that this technology presents.

Other studies [52] (page11) also shows that the use of collaboration systems like Wimba improves the students learning experience and improves the e-learning course that uses the technology.

The positive effects this technology can have is huge but the new technology also introduces new problems because it does not function as a digital representation of an actual teacher lead class but rather as an whole new concept for improving the social aspects of e-learning. These new problems must be understood before the technology is adopted by a teacher. There are technical limitations in how many people that can simultaneously use the program at the same time and the program also demands broadband connections from all students in order to get started. Also the students need to have headphones, microphones and sometime also web cams to use Wimba. Another problem is that the teacher must be trained and experienced in how to use the application, rather than figuring it out as the course starts. This is especially important when taking Wimba's multimodal communications into consideration. The use of multiply forms of communication demands thorough introduction, but on the other hand when properly used truly shows the positive effects of the collaboration systems in LMS systems [54, 55].

10. Conclusions

The most recommended categories of requirements for LMS systems developed for an academic environment is; course content management, evaluation and communication. The requirements in these categories are the most basic functions of an LMS system and useful for handling the content, further improving the course with information from evaluations of existing courses and making the student feel more involved by improving communication.

Pedagogy and the learning process are largely ignored by the developers of LMS systems which are reflected in the studies of LMS systems, and are shown by the lack of references for pedagogical and learning process requirements.

While working with requirements for an LMS systems, either as developer or researcher it is important to take into consideration which market the LMS is marketed to, because there is a difference in the requirements between LMS systems developed for an academic environment or a corporate training environment.

The survey showed that there are also significant differences between open source and proprietary LMS systems. The biggest difference is the service plans offered by the developers. The proprietary developers have more options available for their systems. Another difference is that the open source developers have more and thorough information available on the websites about their systems. Finally there was only one open source system in the survey that supported the digital library requirement while several proprietary systems supported it. This is because the digital library costs a lot for the developers to support.

In order to improve the outcome of e-learning programs using LMS systems three different categories of technologies can be used. First is how the system manages the courses and content within them, which can be improved by adding file sharing between the users, course object repositories to support course object reuse and digital libraries to share course content and information between users and other systems. Second is how the system supports course evaluation and the results of them which can be improved by implementing dedicated course evaluation tools and tools to improve the analysis of the results. Lastly is how the system supports communication between the users, which can be improved by adding communication tools such as chat, wikis, forums, internal messages systems and collaboration systems. These technologies have the largest potential to improve the outcome of the course and they are also easy to implement into an LMS system. For example collaboration systems not only improves the interaction with the student and teacher it also makes the students feel more excited about the course and increases the feelings of being a part of the education. The number of systems that supported the communication requirements showed that communication within the LMS is a high priority for the developers and that the new concepts which improve the social aspects of LMS systems are important to develop.

The different solutions to the communication issues in distance learning are numerous and at a basic level easy to implement. But in order to support a richer learning experience online it is important to make sure that the technology used is right for the purpose and not too complex. The technologies used should be enough to support the work but not take too much time from the education. There is not a shortage of available technical solutions and therefore the most important aspect is to correctly use what's available. It is essential that students have at least a virtual place to meet and discuss issues related to the class and to have some interaction outside of class. However, integrating all of the necessary elements to create a social atmosphere as well as to provide content and support learning require the conscientious integration of many different technologies. The new technologies themselves also present a number of new issues that must be taken into consideration. In the process of introducing the new technology you have to educate the administrative personal, the teachers and the students. They need to be at the same level to be able to collaborate. The courses have to be adapted to the new demands and the teachers must feel a balance between the effort and the results.

11. Final words

E-learning have a very bright future and have the potential to become the dominant form of education in the world, because it transcends the barriers of regular classroom education and harnesses the potential of the digital revolution. Studies [4] [67] have also shown the knowledge acquired from e-learning is of the same quality as traditional education.

But is not without its flaws and they need to be addressed. The rapid expansion of e-learning technologies has left the academic research of the subject behind. Further studies within the field of e-learning could be to develop a complete set of requirements for an LMS system and promote it as the standard for LMS systems. Other research topics could be further studies on the communication tools in LMS systems, how they can be used and what effect they have, also if the creation of a free discussion area in connection to the LMS system can create a more social atmosphere and reduce the number of drop outs.

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