



**USE OF LEARNING MANAGEMENT SYSTEMS IN EDUCATION:
COMPARISON OF OPEN SOURCE LEARNING MANAGEMENT SYSTEMS**

AHMED IMAD YOUNUS YOUNUS

SEPTEMBER 2019

**USE OF LEARNING MANAGEMENT SYSTEMS IN EDUCATION:
COMPARISON OF OPEN SOURCE LEARNING MANAGEMENT SYSTEMS**

**A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED
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BY

AHMED IMAD YOUNUS YOUNUS

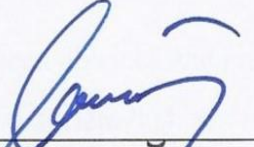
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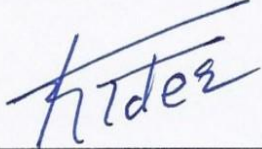
Submitted by **Ahmed Imad Younus YOUNUS**

Approval of the Graduate School of Natural and Applied Sciences, Çankaya University.




Prof. Dr. Can COĞUN
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.



Prof. Dr. Sıtkı Kemal İDER
Head of Department

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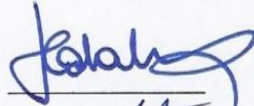
Assist Prof. Dr. Murat SARAN
Supervisor

Examination Date :13.09.2019

Examining Committee Members


Assoc. Prof. Dr. H. Hakan MARAŞ

(Çankaya Univ.)



Assist. Prof. Dr. Murat SARAN

(Çankaya Univ.)



Assoc. Prof. Dr. Gökhan ŞENGÜL

(Atılım Univ.)

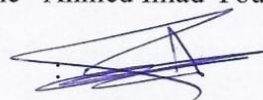


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ABSTRACT

USE OF LEARNING MANAGEMENT SYSTEMS IN EDUCATION: COMPARISON OF OPEN SOURCE LEARNING MANAGEMENT SYSTEMS

YOUNUS Ahmed Imad Younus

M.Sc., Department of Computer Engineering, Information Technology Program

Supervisor: Assist. Prof. Dr. Murat SARAN

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Today, new information and communication technologies (ICT) have been involved in all parts of life, such as medicine, engineering, and even social life. One of the most effective ways to use ICT in a beneficial way to human life is education. Some universities use e-learning systems to increase the learning rate and accessibility. In this study, we have compared the learning management systems (LMS) using criteria developed according to the opinions of educational technology experts by focusing on open source systems. The learning management systems used in this research are Moodle, OpenedX, and SAKAI due to their popularity and widespread use. The results of this study can help decision-makers looking for an LMS that suits their needs to select the systems that meet their requirements. In our research, we have collected and combined many comparison criteria for LMSs from previous studies and then developed novel criteria set by adding new points of comparison. Moreover, we proposed a new evaluation methodology. In this thesis, we have described the method we have introduced in detail and presented how each LMS performs in each criterion. We found that Moodle has the best features compared to

others. According to our evaluation method, Moodle scored the highest score (69 out of 74), followed by OpenedX (63 out of 74) and Sakai (58 out of 74).

Keywords: e-learning, learning management system, comparison criteria, Moodle, Sakai, OpenedX



ÖZ

EĞİTİMDE ÖĞRENME YÖNETİM SİSTEMLERİ KULLANIMI: AÇIK KAYNAK ÖĞRENME YÖNETİM SİSTEMLERİNİN KARŞILAŞTIRMASI

YOUNUS Ahmed Imad Younus

Yüksek Lisans, Bilgisayar Mühendisliği Anabilim Dalı Bilgi Teknolojileri Programı

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Günümüzde, modern bilgi ve iletişim teknolojileri (BİT) tıp, mühendislik ve hatta sosyal yaşam gibi yaşamın tüm kısımlarına dahil olmuştur. BİT’i insan hayatına faydalı bir şekilde kullanmanın en etkili yollarından biri Eğitim’dir. Bazı üniversiteler, öğrenme oranını ve erişilebilirliği arttırmak için e-öğrenme sistemlerini kullanmaktadır. Bu çalışmada, popülerliği ve yaygın kullanımı nedeniyle açık kaynaklı sistemlere odaklanarak ve eğitim teknolojisi uzmanlarının görüşlerine göre oluşturulan karşılaştırma kriterlerini kullanarak e öğrenme yönetim sistemlerinin (LMS) karşılaştırmasını yaptık ve sonuçları sunduk. Bu araştırmada kullanılan sistemler Moodle, OpenedX ve SAKAI’dır. Bu çalışmanın sonuçları, taleplerine uygun bir LMS arayan karar vericilere gereksinimlerini karşılayan sistemleri seçmelerine yardımcı olabilir. Araştırmamızda önceki çalışmalardan birçok karşılaştırma kriterini toplayarak birleştirdik ve daha sonra yeni kriterler ekleyerek geliştirdik. Sonuç olarak, LMS karşılaştırmaları için bir kriter seti oluşturduk ve yeni bir değerlendirme metodolojisi önerdik. Bu tezde önerdiğimiz metodolojiyi ayrıntılı olarak açıkladık ve her bir LMS’nin her kriterde nasıl performans gösterdiğini sunduk. Moodle’n diğerlerine göre en iyi özelliklere sahip olduğunu bulduk. Önerdiğimiz değerlendirme yöntemine göre Moodle en yüksek skoru aldı (74 üzerinden 69), sonrasında OpenedX (74 üzerinden 63) ve son sırada Sakai (74 üzerinden 58) yer aldı.

Anahtar Kelimeler: e-öğrenme, öğrenim yönetim sistemleri, karşılaştırma kriterleri, Moodle, Sakai, OpenedX

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CHAPTER 1

INTRODUCTION

From the beginning of the development circle, human life has been affected by it and real change accelerated with the invention of computers. Many fields related to the computer were related to human needs. Most notably in the educational field, many techniques have been improved and from those fields came e-learning. Many higher institutes in developed countries have increased their learning and teaching rates [1]. Many researchers clarify the aspect of information and communication technology (ICT) to enhance the e-learning effect [2]. E-learning has an on many countries including developing countries such as Rwanda [3] [4].

Using e-learning management systems has many benefits that can be summarized thus [5]:

1. Learning management systems are used to manage distance learning and online systems as examples.
2. Learning management systems give the ability to create and support many online learning courses that are accessible for many students around the world.
3. Online Quizzes, which provides the learner with challenges and can be a good measurement for the class understanding.
4. Course repositories, is where you can find the materials for subjects and the availability of them is a crucial need.
5. Good community environments to exchange ideas between students and instructors.
6. Mailing ability.
7. Multilingual interfaces.

1.1 Aim of the Study

In this study, we make a comparison of e-learning management systems and we focus on open source systems and provide results with criteria according to the opinions of educational technology experts. We will be comparing between three open source learning management systems: Moodle, OpenedX and Sakai. This will help decision makers who are searching for systems that suits their demands and select systems that meet their requirements

1.2 Significance of the Study

Migration from one LMS (Learning Management Systems) to another is a challenging process that might contain a full reconstruction of course materials or even websites. Since decision-makers will be responsible for their LMS choice, they must choose the right systems that meet their requirements. In our study, we provide a benchmark with criteria that makes the selection decision easier for them without repeating the evaluation process that shows the strengths and weakness of LMS systems. Our criteria are standardized and determined by educational technology experts on e-learning systems.

1.3 Research Questions

- 1) What are the evaluation criteria that determine the LMS system that best meets academic needs according to the educational technology experts?
- 2) Which of the widely used open-source learning management systems such as Moodle, Sakai, and Openedx meets the criteria set by educational technology experts at the highest level?

1.4 Related Work

Many people around the world found their missed need for learning through the Internet, especially online courses on what is known currently as distance learning [6]. Therefore, many universities and institutes have focused on increasing their teaching rate with e-learning and found the opportunity with that learning [6] [7]. Many researchers have studied different LMS systems and measured them with different criteria. A study made by Cavus and Zabadi [8] focused on six open-source LMS systems: Atutor, Claroline, Dokeos, Ilias, Moodle, and Sakai.

The comparisons were between those systems from different aspects.

The main comparison points were:

- Whiteboard/video services;
- Discussion forums;
- File exchange/internal mail;
- Online journal mail; and
- Real-time chat.

The work concludes that Moodle is one of the best LMS systems among the other LMS systems with a rating of 8.3 and a high number of users around the world with 70,696,570 users in June 2013. Moreover, the conclusion stated that Moodle and ATutor were the best in terms of friendly user interface and accessibility of information, Ilias was excellent from the perspective of availability. On the other hand, Sakai and Claroline provide a complexity of content, which makes it difficult to retrieve information. All the systems mentioned in the paper have a discussion forum. At the end of the paper, the authors gave promising hope regarding the developments of LMS systems and stated that it might be challenging to decide which LMS would be the best in the future. Fertalj, Jerkovic, and Hlupic [9] published a paper comparing ten

LMS systems and discussed four main issues:

- Proprietary of Learning Management Systems;
- Open Architecture in Learning Management Systems;
- Mainly proprietary and partly standard-based Learning Management Systems; and
- Mainly standard-based Learning Management Systems and partly proprietary Learning Management Systems

The conclusion stated that the “standard/proprietary” systems at the current time lead the e-learning market as well as the near future and that *Moodle* has the largest community and ranked the LMS in the Table 1.1.

Table 1.1: Rankings of compared LMS Systems [9]

Type	LMS	Rank
Standard/Proprietary	ANGEL 6.2	1
Standard/Proprietary	WebCT Vista 3	2
Standard/Proprietary	Black Board Academic Suite	3
Proprietary/Standard	+Ecollege AU	4
Open	.Moodle 1.5	5
Open	Sakai 2.0	6
Proprietary/Standard	Learnwise	7
Proprietary/Standard	Learning Manager Enterprise Edition	8
Proprietary	Jenzabar Internet Campus Solution 1.03	9
Open	Claroline 1.4	10

In other work performed by Subramanian, Zainuddin, Alatawi, and Javabdeh [10] the success of the online LMS systems was discussed from the perspective of learning and interactive structures. Moreover, the paper presented a discussion of the harness effect of LMS systems on students' ability to take action during an online course. They compared the basic functionality of the LMS systems regarding the (1) Communication tools, (2) Productivity tools, (3) Student involvement tools.

[11] suggests ten factors to measure any LMS system regardless of the size or the environment that uses that LMS. These factors include the following:

- Technical support
- Design
- Friendly interfaces
- Repositories that are well designed
- Organized objectives
- The ability to administer a course
- Sharing and interactions between users
- Feedback
- Profiles
- Pedagogy

As a final result, the paper declared *Moodle* to be the best LMS virtual learning system with the necessary tools that transform and update the present educational system. Again, they claim that it is too early to determine which system is better in the future. Another work has suggested that the students' needs might differ from one another. In that study, they found that the students on the commuter campus preferred learn-to-learn methods, while the residential campuses preferred more interactions within the content of the course [12].

In conclusion, the user's requirements will continue to change from time to time and from one place to another, and we will always encounter different people with varying opinions. Here, using standard factors will provide accurate feedback on any LMS system appearing or being developed in the field.

1.5 Thesis Structure

This thesis consists of five chapters. Chapter 2 presents a review of the literature about the systems. Chapter 3 explains in further detail the methodology of the LMS systems we selected for this thesis. Chapter 4 presents the results of the practical part, and Chapter 5 concludes the work and the results and discusses future work.

CHAPTER 2

LEARNING MANAGEMENT SYSTEMS

2.1 What are Learning Management Systems (LMS)?

As we all know, the regular classroom has an open environment and gives the student more to interact with the lecturer. On the other hand, many students lack the courage to participate in class, and this directly affects their academic requirements. Here appears the online learning to cover those learning objective needs for users and especially students [13] [14] [15] Moreover, forums have expanded the community of LMSs further and enable sharing of knowledge between students, especially when there is the ability to interact with users and the instructor [16]. Additionally, there are no constraints on time or place [17], and opportunities are provided not to attend a real class for people with a fear of participating in a class [18]. LMSs have been designed to transform the manner of learning [19] and were fully commercial initially [20]. An LMS should have the ability to manage, track, and deliver learning to different groups of people regarding their work or educational backgrounds [21].

2.2 Types of LMS

There are different types of LMSs, and most vary in their design but share the same concepts. To understand conventional LMSs, it is necessary to clarify their categories according to the central ideas underlying their design and architectures.

The most common types of LMS are as follows:

2.2.1 Free vs. Commercial

Comparing to the commercial, the free or the open-source LMSs have a direct impact on the users. Firstly, it is free. Secondly, the source code is available, which makes it customization regarding the user demands easy. The commercial provides the user with the support from the developers, and it is easier to maintain. The only problem in these LMSs is the cost.

2.2.2 Installed vs. SaaS (Software-as-a-Service)

The difference between the installed and the SaaS products is that the installed one required hardware only specification such as memory. This one offers the user the ability to maintain and update the system, but it requires staff to manage these operations. Otherwise, the SaaS software does not require an expensive cost for hiring a team for updating the maintenance, and it also assures a high availability with a small cost depending on the software [22].

2.3 Main Elements of LMSs

The following elements are the central parts of Learning Management Systems to exist:

1. **Hardware:** Many devices, such as PCs, smartphones, notebooks, iPads can be used to access an LMS. Such devices provide different media support, including pictures, videos, and many other types of mediums. Initially, PCs and notebooks were the only devices being used to access LMSs. With the modern technology revolution, usage has expanded to include mobile phones and notepads. Additionally, networks such as WAN, MAN, WLAN, or even Intranets are central parts of modern LMSs; these are the communication elements in an LMS. CDs and DVDs can be elements in some hybrid LMSs [21].

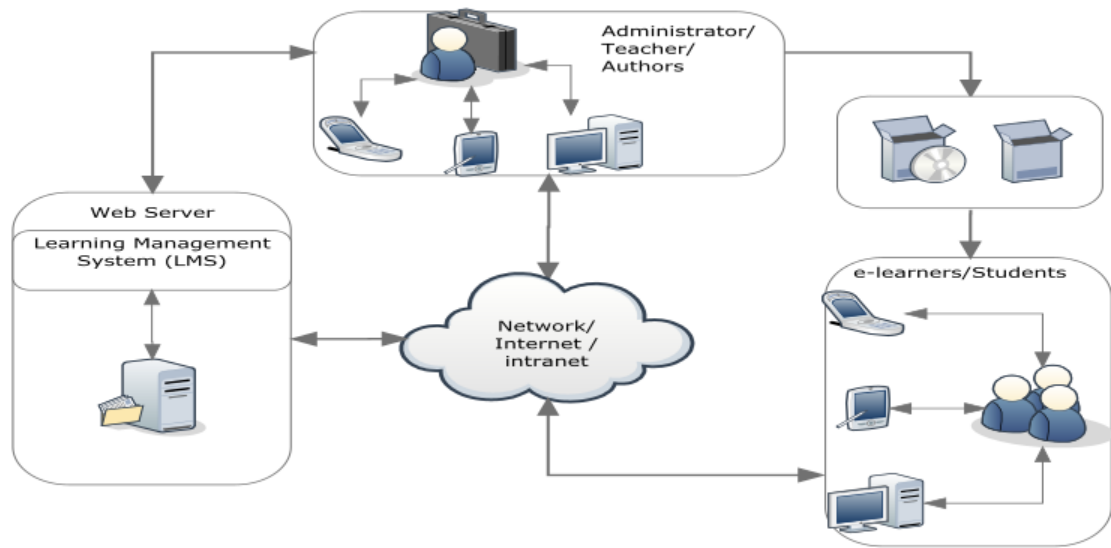


Figure 2.1: LMS hardware parts [21]

2. **Software Component:** The software is the most critical element in an LMS because it contains the materials and the environment of the class. The main features that should be found in any software component for an LMS are accessibility, customization, and flexibility. Moreover, software components should support the materials in different representations such as HTML that contains PDF, Word, or even PowerPoint slides and animations [23]. The courses and course materials are designed by tools developed by companies and those companies most of the time charge money for the use of those tools, including suit authoring tools developed by Macromedia and Adobe companies (known as "Macromedia Authorware" and "Adobe eLearning Suite." Additionally, we have the online Authoring Tools that are provided by websites such as UDUTU as an example of that kind of LMS. Here, we can either use it on the website or download materials to our own LMS [24]. The last version of authoring tools is open source. These can be used gratis, and they can even be modified in their source code without any violation of licenses. Table 2.1 and Table 2.2 list commercial and open source authoring tool

Table 2.1 Commercial Authoring Tools

Tool	Owner	Website
Wondershare Rapid E-Learning Suite	Wondershare	http://www.sameshow.com/e-learning-suite.html
Adobe e-Learning Suite	Adobe	www.Adobe.com
Macromedia Authorware	Macromedia	No longer supported after Adobe merged with Macromedia
Articulate e-Learning Software tools	Articulate	/http://www.articulate.com

Table 2.2 Open Source Authoring Tools

Website	Owner	Tool
http://www.udutu.com/index.html	UDUTU	UDUTU online Course Authoring
www.exelearning.org	The University of ,Auckland Auckland University of ,Technology Tairawhiti Polytechnic	Exe Authoring Tool
/http://www.nottingham.ac.uk/xerte	University of Nottingham	Xerte and Xerteonline toolkit

2.4 Learning Management Systems Anatomy

An LMS may be defined as software that provides learning and teaching processes and tracks them for users regardless of whether users are lecturers or students. An LMS and an open-source installed-free portal are connected to a database and manage the content of courses with the user interface and record actions to retrieve them when necessary [25]. A sequence of actions can be handled by installed-free system and those actions consists of accessing courses, memorizing the progress of the education and generating statistical information for all the usage of the content, recording the time that users spend on a course, recording the start and end times of courses and recording courses in which users are interested and in which they might enroll [26]. Such information helps to save time for suggestions of courses, and it can give a clearer understanding of the effect of a course, thereby saving time and reducing costs [27].

2.5 Comparison of Learning Management Systems

Many papers have covered LMS comparisons, with criteria varying from paper to paper. Some have covered insufficient features while others have covered as many features as possible to make better comparisons. We searched for various papers to determine our criteria. Some papers used experimental evaluations, and some focused on comparing different LMSs. To select the proper LMS, we need to use many factors as criteria [28]. In 2007 [29], a paper presented a study on the comparison methods that have been used from 1998 until 2007. The paper stated that from 30 papers, 17 focused on feature comparisons while others compared them with different criteria. However, the work did not gain attention on account of the technical comparisons. There should be an amount of flexibility when selecting any LMS, and this would offer various options to both tutors and students and make it useful for pedagogy. From a study in 2005, the study concluded that 94% of higher educational facilities in the US studied using one LMS, at least during the study [30]. Due to the functionality of LMSs, the complication increases. Nevertheless, there is a study stating that an LMS should be centered around three main

points: usability, reliability, and support [31] as the main criteria. Secondary criteria include [32]:

- financial support
- integrity
- long viability
- pedagogy
- technical support

Nowadays, users' attitudes attract functionality over any other criteria. The reason for this is the direct connection between functionality and users' need for moderating the LMS and for content manipulation. In our work, we depend on criteria that are focused on the functionality of an LMS. To make a good comparison, we need to identify the functionality of the LMS. According to [33], functionality is the software mechanism to overcome users' demands under the control of the constraint. We can also use the functionality to scale the satisfaction of users for the LMS they are using [28]. There are four functionality features created by [29] and [34]. The criteria have been inspired by the work of Abdullatif [35]. The main criteria include the development of courses, activities, tracking courses, assessments, and learners' communication. We dropped the additional criteria such as news and calendar. The criteria we used were the results of work from many previous papers, and by using those combined features, we were able to obtain a pure technical criterion that serves user needs.

Eight main factors have been identified by Hoffman to measure any successful technology [36]:

1. **Administration:** Any technology needs to be supported by facilities by providing the appropriate staff and assisting them with their needs and requirements.
2. **Technical support:** Any technology can be complicated and needs to be developed rapidly, so it is necessary to provide the appropriate staff with the right skills and experience to train and develop the team that will use the technology.
3. **Availability:** Any technology should be available as the user needs it, and it needs to be accessible at any time when requests appear.
4. **Use Plan:** Funding is essential for any technology, and there must be a plan for its implementation. A plan may last between 3 and 5 years to ensure that a system is developed through the stages of the plan.
5. **Coordinator:** For any technology, there must be a person that controls the workflow and assists in training to create a capable system.
6. **Maintenance:** Installation and continuous maintenance of the system assure that the system will work effectively for an acceptable period. It might struggle when there is a problem in the system, but there will be a higher probability for the system to work rather than fail or become disabled.
7. **Assessment:** Consideration for any system to succeed needs to be calculated, and that score can be collected from scoring test systems to provide a clear view of the system working.
8. **Broad Participation:** For any system, there must be an implementation for it. Therefore, this implementation cannot be performed by one person. There must be staff with different skills cooperating to work on a successful implementation.

2.6 Learning Management Systems Used in This Study

All the LMSs used in this study are open source. The benefits of open source software are its lower cost, high reliability, flexibility, and quality [37]. These criteria determine whether software would be considered an open-source based on the Debian Free Software Guidelines [38]. The main reason for this concept to offer the source code of the software to others and permit them to reconstruct and modify the software freely under the general public license (GPL or GNU). Open-source software is more flexible than commercial software due to the ability to customize open-source software. Additionally, usability is better in open-source software. Most modern facilities and schools have adopted open-source software, most notably LMS, which is the reason for its suitability within the educational style of those institutes. In contrast, commercial LMSs cannot cover every user's demands, and it does not suit the style of the educational philosophy. Open source LMSs are more flexible than commercial software, and they can be modified to meet users' needs [39].

2.6.1 OpenedX

OpenedX is an open-source LMS platform founded at the end of 2013 as a collaboration from many institutions the most well-known of which are Harvard University and MIT. It now provides many users with courses from different sections, and many courses have been added by leading universities, such as Harvard, MIT, and Boston University. Even a prestigious organization provides courses on OpenedX, including organizations such as ETS, Microsoft, UC Berkeley, and the Linux Foundation. Later, Google shared its knowledge with edX and transformed into MOOC, an acronym for Massive Open Online Courses. In this work, we used the Ginkgo.2 versions [40].

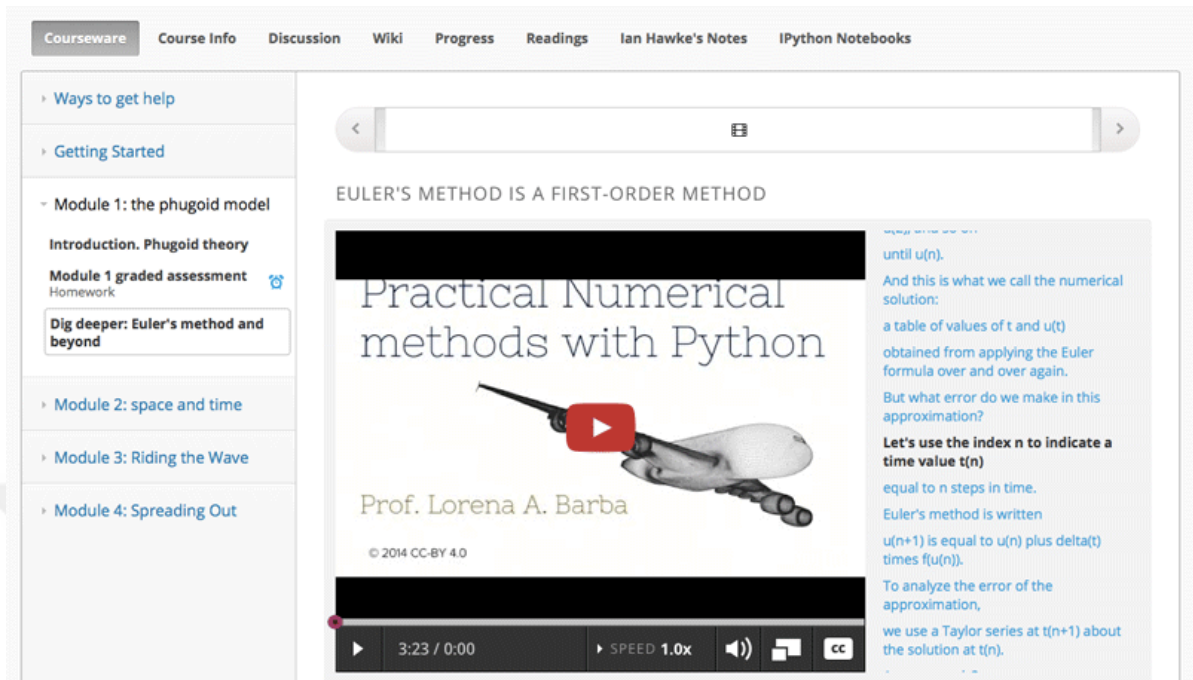


Figure 2.2 OpenedX user interface

2.6.2 Moodle

Moodle is an acronym for Modular Object-Oriented Dynamic Learning Environment and is an open-source LMS. It has many features that make it one of the more popular e-learning applications. In addition to being an LMS, it is also a Course Management System (CMS) and a virtual learning environment (VLE) [41] [42]. Moodle has more than 98,862 registered sites distributed among 234 countries with 129,433,013 users [<http://moodle.org/stats/>]. Moodle has eighty languages and a Graphical User Interface (GUI) [Moodle.org, 2018]. It was created by Martin Dougiamas during his Ph.D. study [43]. Moodle has many features, such as content management, multi-support from many applications, communication with others in a course, quizzes and exams, and community sharing. *Moodle* has an independence platform, which means it stores information in separate storage systems such as databases and it supports many versions of database management systems, including Oracle, Microsoft SQL Server and MySQL [44]. Moreover, it is fully open-source and can be copied and modified under the GNU license [41] [43]. In this study, we used version 3.4.2+ of Moodle [41]



Figure 2.3 Moodle graphical user interface

2.6.3 Sakai

Sakai is one of the most popular LMSs known in the market. It is an open-source LMS with a vast global community of users. It also provides users with many tools, such as teaching tools, generic collaboration tools, and workspace tools [45]. *Sakai* was developed by four American universities (MIT, Stanford University, University of Michigan and Indiana University) in collaboration with the Jasig organization in 2004. After the initial development, many universities and colleges joined the original four universities in the project (such as the University of California, Berkeley University, and Foothill Community College). Each of these universities contributed tools to the project known now as the "Sakai Project," which was originally funded by the Mellon Foundation. The most significant contributor was the University of Michigan, which named the LMS *Sakai* due to the critical effect on the project by the project leader Hiroyuki Sakai. The project was developed in the Java programming language and was available officially in 2005. With more than 350 facilities around the world using it, and having been translated into more than 20 languages, Sakai has served approximately 5.25 million students, one million of whom are outside the U.S. In our work, we used the 12.0 version [46] for the installation for the LMSs used in this work see (Appendix A)

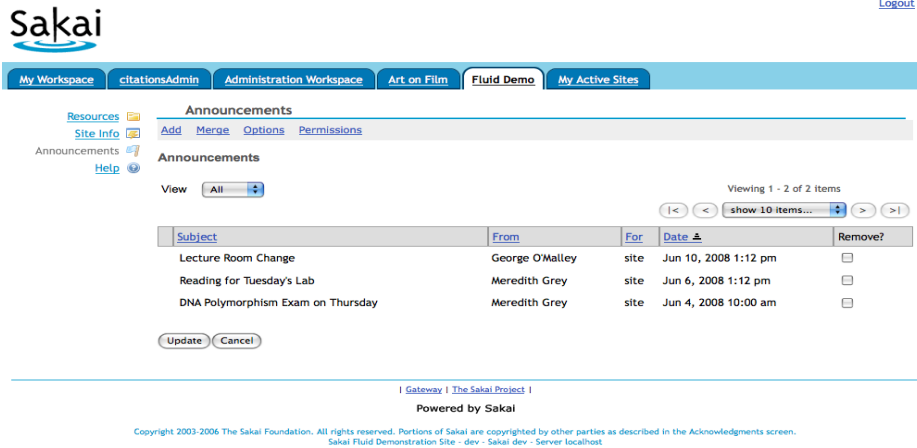


Figure 2.4 Sakai user interface

2.7 Market Share

Most software yields to the competition between companies. The software industry is a multi-billion-dollar industry. Nowadays, the foundations of LMSs endeavor to exceed their rivals by adding many new features or by updating the current version according to user demand. This kind of competition has contributed to the development of LMSs over the past years, and it has brought LMSs into their current form. Initially, many LMSs had fluctuated in the market, and many of them leveled off for many years. Although the famous names in LMSs, such as Sakai and Moodle, dominated the market for many years, many LMSs have been brought to the forefront because of their compatibility with users' needs. By comparing the requirements of many institutes and educational centers, each region wants different claims, and this returns the orientations of the people in that area. By taking the US as an example of the market share for LMSs, we found that many LMSs, such as Canvas, arose dramatically and surpassed even the widely used LMSs, such as *Sakai*, while Blackboard gradually decreased but still ranking first as the most used LMS in the US until March 2018. Moreover, the market in the US tends to commercial LMSs, and the study has compared open-source LMSs in order to bring the best among them to

the front interface and focus the attention of the developers on them. Figure 2.5 shows the US market share of LMSs until march 2018.

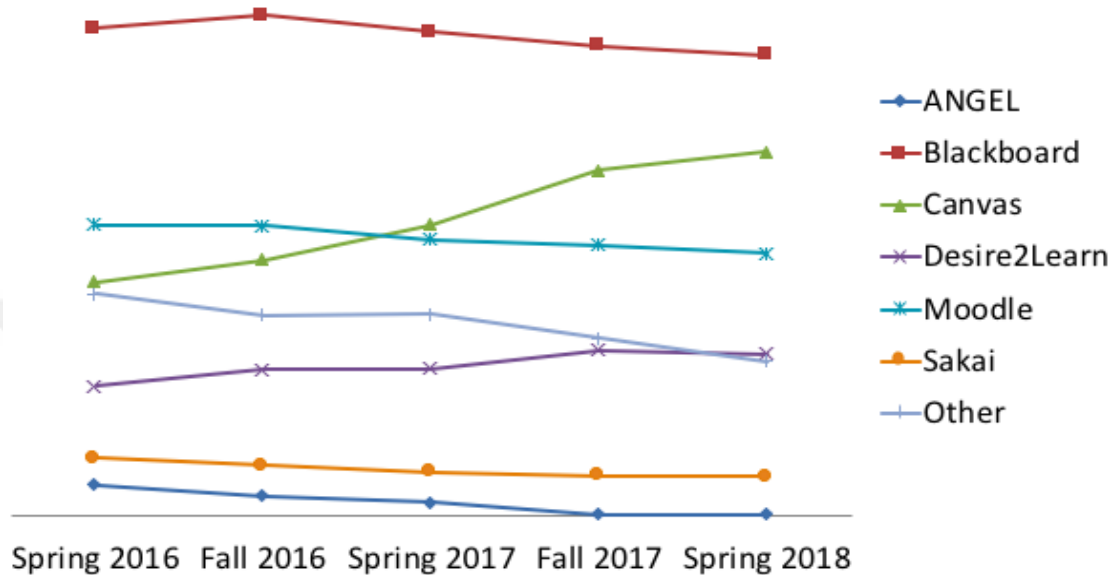


Figure 2.5 Market share of LMSs in the US

However, there is a need to mention many countries for this kind of comparison, and this will create ambiguity for the researcher due to the large differences in users' requirements. In 2017, a comparison provided by the Edutechnica website [47] illustrated that most LMSs are used in four countries (US, Canada, UK, and Australia), and by looking at the statistics of the study, there is a clear contrast in the usage of the LMSs in those countries. For instance, in the US, the most used LMS is *Blackboard*, which is a commercial LMS, while in Canada, *Moodle* (an open-source LMS) has invaded the market. An identical scenario applies in the UK except that it has a higher value for Blackboard than in Canada. Finally, in Australia, Blackboard dominates over other LMSs and competes with Moodle, which is the second most used LMS in Australia.

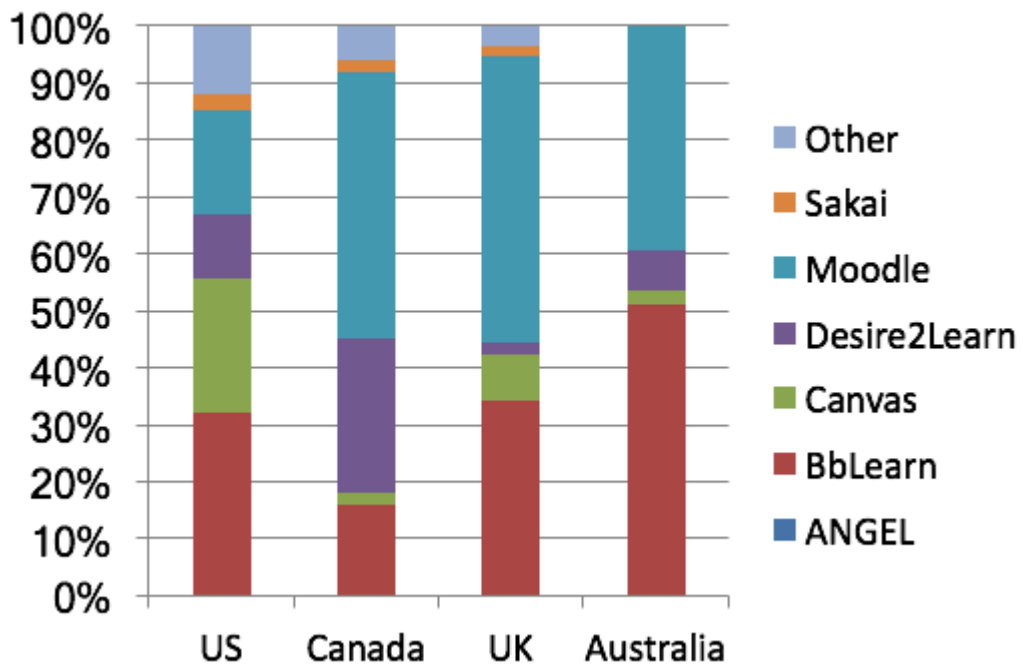


Figure 2.6 LMS usage in different countries in the fall of 2017

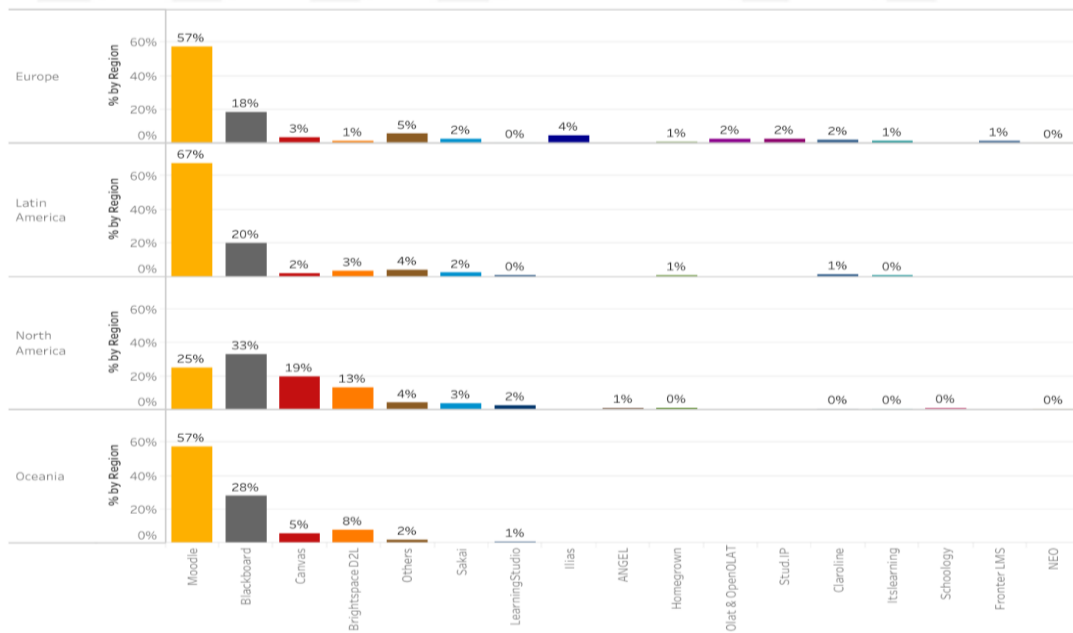


Figure 2.7 LMS Usage data from LISTedTECH [48]

Another source from (LISTedTECH) which appears Moodle is the most used one in (Europe, Latin-American, and Oceania) after Moodle Blackboard is used one in thus countries, in North America Blackboard is common after that is Moodle.

The learning management systems evaluated in this study have been selected according to their market share. The first two widely used open-source learning management systems, namely Moodle and Sakai, and one of the new open-source learning management system called OpenedX, were selected in this thesis. See (Figure 2.7).



CHAPTER 3

METHODOLOGY

In this chapter, we present a detailed explanation of the criteria determination process, an experimental method that we used in this study including the explanation on how we set up the Learning Management Systems on a server. The evaluation methodology employed in this thesis is divided into two steps, as shown in Figure 3.1.

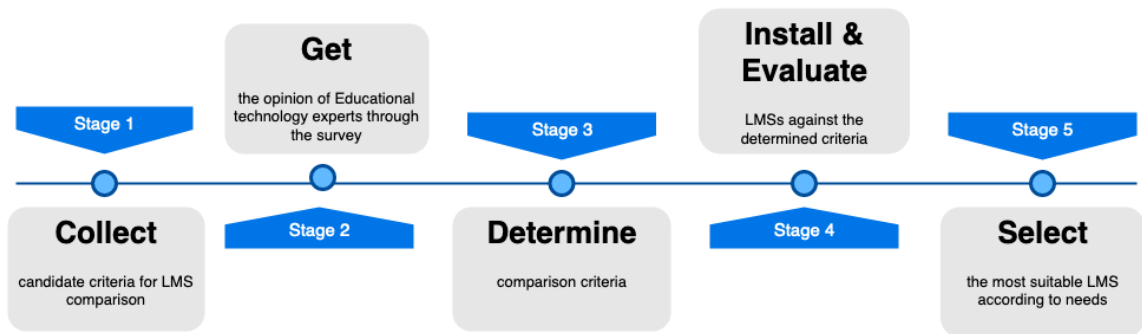


Figure 3.1 Overall LMS Evaluation Methodology

The first, second, and third steps explain how to develop the necessary comparison criteria to evaluate the learning management systems according to the opinions of educational technology experts by using an online survey. How to analyze the collected data and how to categorize the data is explained in these steps. The fourth and fifth steps comprise testing the systems according to the criteria determined in the survey.

3.1 Determining Comparison Criteria

While determining the comparison criteria, we first collect the candidate criteria from the previous studies and add new criteria that are not available in the earlier studies. Then, we survey to get the opinions of the educational technology experts. The following parts first explain the candidate criteria and then the expert survey process.

3.1.1 Candidate Criteria

In this step, first, a pool of candidate evaluation criteria set for Learning Management Systems was developed in order to select the criteria that will be considered in our evaluation methodology. The pool comprises a set of 70 candidate criteria selected from previous studies [28] [29].

The criteria are organized under ten categories covering the following essential aspects:

- 1) System Management Criteria
- 2) Reliability Criteria
- 3) Usability Criteria
- 4) Learning Analysis Criteria
- 5) Security and Privacy Criteria
- 6) Communication Criteria
- 7) Authorship tools Criteria
- 8) Evaluation Criteria
- 9) Support Criteria
- 10) Course Management Criteria
- 11) The criteria categories and their sub-criteria are explained below:

Category 1: System Management Criteria

In addition to the user interface, these criteria measure the manipulation of the system regarding the use, installation, and management of the main sections inside it.

1. Ease of Installation: Here, we are taking into consideration the time consumed in installing the exam regarding its difficulty. Most of the installations differ depending on many factors, from which we have the number of dependent and independent libraries required to be installed to have the program function correctly. Much open-source software requires additional software to make it work, which is a return to a policy of use for the GNU license.

2. Installation Time: In this criterion, we took the installation time into consideration due to its importance in the survey depending on the result as it scored as an absolutely important factor. The installation time contrast from one software package to another depends on the number of additional programs and libraries that are required to be installed beforehand.

3. OS Compatibility: In the current time, there is much invisible competition between operating system developers, and for a long time, open-source was not considered to be far-flung software. After the expansion in the use of open-source software, rivalry increased markedly. Many programmers around the world started to immigrate to open source programming languages and software. This forced developer to create programs that would work on different platforms due to the variety of user preferences.

4. System Update Features: In this criterion, we considered the ability of a system to update and whether the developers inserted update systems to avoid bugs. The most critical elements are security and loss of data. Many developers create unique programs without putting many features into them due to the lack of planning for future use. Therefore, many open source programs require periodic enhancements.

5. Maintenance and Upgrading: This factor pertains to major updates for software as a complete platform. In modern times, many technological aspects changed with rapid improvements in the fields of computer science. One important feature is the ability of a system to upgrade itself without the need to install a new version which might significantly affect data and potentially cause a loss in information.

6. Application Programming Interface: This criterion was also selected as one of the impact factors in our survey. The importance of the API comes from the first impressions of users and how easy it is to use a program effectively without complexity or prior knowledge about the system.

Category 2: Reliability Criteria

For these criteria, we focused on protection and the ability of an LMS to retrieve data after loss and whether a system can store a copy of the user's information. Moreover, in these criteria, we have to measure and estimate the performance of an LMS (LMS Health Check or Error-Prone). Finally, we cover the correctness as an essential standard.

1. Backup and Recovery: The importance of this feature comes from the capability of the system to store copies of the data and the databases for a user to retrieve them in case of data losses or security issues. The other part of the feature is recovery such that the LMS should be able to regain the data when any risks end or for a new fresh system where the user brings his data to a physically better environment.

2. Error-Prone: This feature shows curves to evaluate the health of the system and whether it is working correctly. Moreover, it shows the flow of the data and presents an analytical view of the LMS. Those data are essential for users and experts. The data are used to benchmark the systems and how each LMS handles the data and the flow of the information inside them. Moreover, the data give a prior notification if there is something going wrong, and that could be a fatal danger to the LMS.

3. Correctness: This criterion is considered to be a scientific standard because it is utilized in a systematic perspective to measure the ability of an LMS to return a correct result while being compared with the total result. Usually, such features should be measured with an embedded system; however, we covered them regarding the final research performed on the LMSs mentioned in our work. The underlying factors here are computational accuracy and precision.

Category 3: Usability Criteria

Through most of the criteria we have covered in this section, the only one remaining that is essential is web browser support.

1. Support for Existing Browsers: Nowadays, we have a range of popular web browsers, such as Google Chrome and Mozilla Firefox and many others, and the crucial part is the user's use of those programs. It is crucial to determine whether the LMS supports those browsers.

Category 4: Learning Analysis Criteria

In this part, we covered most of the criteria that focus on the statistics that can be observed and collected through the monitoring characteristics in an LMS. The main benefit of this section is to provide the manager of the course with any necessary information to enhance the learning rate for the students. Furthermore, it mitigates the exertion consumed in teaching the students with high learning pace.

1. Providing Reports on Student Progress: An LMS with such a feature as this has a high potentiality to get more information about attended students. It has a higher success rate with all the information that the user can gather from reports which might aid him in enhancing the course and recognize the level of learning for each student.

2. Time Analysis Feature: This feature helps the user to compare the activity of students by knowing times of login to the course and log out to check the time the student has spent in the course. It also helps to give any details about the latest active student in the course.

Category 5: Security and Privacy Criteria

One of the critical problems in the cyber world is security. Most modern technology requires sophisticated protection techniques to prevent leakage of information, especially private information. For LMSs, this is still a real problem that requires further upgrades that are sometimes not occurring in a short period and being updated continuously. We covered the security issue and made it the central part of our survey. After making selections from the users, we obtained the following standards.

1. Different Types of User Support: Any LMS can be used around the world for multiple users. However, there is still an urgent situation when a course should be manipulated by multiple users when materials differ each period or each level within a course. Although it is not difficult to comprehend the importance of such a feature, the problem becomes acute when the level of security in that LMS is limited by simple procedures.

2. Validation of Input Feature: Validation is an essential factor in any information system. It helps to provide identical data and prevent any duplication which can take space in memory and possibly give wrong corresponding for a user's demand for data. The system should also provide the user when any data are duplicated to mitigate the effort and notify the user in advance.

3. Data/Document Encryption Feature: Data in an LMS should be encrypted with a robust algorithm to guarantee a high level of protection from vulnerability. Moreover, the system should retrieve data for the user regularly without difficulty by not showing the decryption process to the user. The algorithm should be robust and require a complex key and inform the user to use the right password with various types of characters.

4. SSL Certificate Layer Support: The SSL (Secure Socket Layer) certificate is a protocol used in the network to encrypt information from the server to the user and vice-versa. The importance of this protocol is critical, and this returns to the fact that it protects data from being readable until it reaches the end-user. This ability protects the data.

5. Email Verification Feature: This feature is modern, and most websites use it in modern times. This feature asks the user to log in to the system after entering the system through a portal link sent to the user's email that was used for registration in the system. This procedure protects both the system and the user by disallowing and registering without ensuring that it is the correct user with the same information.

Category 6: Communication Criteria

Always communication considered as one of the most critical instrumentation in modern life. We cover these criteria as the sixth criteria section in our work due to the high results scored in our survey.

1. LIVE Video Conferencing: If an LMS provides a streaming method for either voice or video media, then the course provides information in real-time, which makes such a course very close to a real-life course. It is a beneficial way to give the student the best method to participate in course discussions, and it also helps them to ask the teacher directly without any communication difficulties. Moreover, any student can take a course regardless of its location, which means that a course may contain many students from different countries, helping them to build friendships and share knowledge.

2. Private Email Feature: Internal email is useful for sending notifications about a course and helping to solve problems occurring for students. It is also a beneficial secure communication method without the need to communicate with different emails that may contain spam, thereby preventing them. The use of external email requires additional network complexity

3. Forum Feature: One benefit of a forum is that it helps students to share their information with others and exchange knowledge between them. A forum also helps to decrease pressure on the lecturer to answer questions, especially when there are identical questions from many students.

4. Whiteboard: A whiteboard is a simple but useful tool to extend an explanation and draw one's ideas. It helps when the student or tutor needs to represent his idea graphically. He can open the whiteboard in the LMS and start drawing figures to represent his ideas.

5. File-Sharing: A sharing system is an excellent method in the development of the LMS. A tutor can share additional resources to help students to understand a topic easily without the need to launch into an unnecessary explanation about topics that might be secondary subjects to the main subject of the course. Alternatively, it might be a central part of the course regardless of how well explained it is in another resource or even a course.

Category 7: Authorship Tools Criteria

The ability to manage the materials inside a course is also one of the crucial leads in our survey and acquiring most of the attention in our survey because of its direct impact on course knowledge. It represents the technical manipulation of the course and its materials.

1. Linking: An LMS may contain additional resources for the course, and some of those resources have copyrights. Therefore, an LMS needs to provide users with a linking method for scientific information or materials that belong to other courses. This may also be used to decrease the time for the recreation of information. Instead, it merely navigates the user toward the appropriate data, websites, or even tools.

2. Create/Delete Courses: Most modern LMSs include an add-delete feature which gives the user the ability to create many courses and easily delete them after finishing those courses or due to a technical reason related to a particular user.

3. Upload-Download Resources: As is the case for any software, an LMS needs to contain media content. However, since an LMS can contain many courses, there is a need to modernize it with the latest items. There are many types of media, including images, flash videos, and document files. The LMS should be able to upload and download such items easily and compress them into one archive file, such as a Zip file.

4. Course Template: Whenever a user searches on the Internet, there is a special feature that attracts his attention. This feature is widely used on YouTube and many other websites for videos. This feature is called a template which inserts a picture either from videos or as the owner desires. This template gives the user a first impression of the course. It is useful in an LMS and gives it a more aesthetic appeal.

5. Interactive Activities During Learning: Doing activities in a physical classroom can bring about more significant learning outcomes and more enjoyment to the students. Similarly, in a virtual class, doing interactive tasks within a course provides more learning in the class and helps to decrease decreasing the consumed time in getting new material maybe by a small detail.

6. Online Quiz Editor: For any modern LMS, there is a need to meet at least some criteria from the real educational world. One of the basic needs is to grade the student and compare their development through *quizzes*. A quiz is a small exam provided by the teacher for students to check their comprehension of the course information. Identical to that found in the real world except for its more technical aspects, it helps to achieve better results expressively. Moreover, it helps to make the grading system superior in terms of speed and analysis. A useful quizzing feature for a Learning Management System is the tutor permissions that create courses and modify them easily. Due to all the facts mentioned thus far, online quizzing is considered to be one of the most effective technical sub-feature criteria in LMSs.

7. YouTube Integration: Since it is one of the largest sources of various types of videos, content can vary from entertainment to tutorials. YouTube is considered to be one of the most productive resources for learners which feeds courses with visual education. Moreover, it can contain more effects and graphics inside a video to facilitate the explanation of subjects in a course.

Category 8: Evaluation Criteria

Psychologically, self-assessment is a process of measuring our abilities regarding a specified aspect. Self-assisting helps the student to improve by offering him a small exam after a lesson or a course to measure his knowledge. Additionally, this assists more introverted or diffident students to change their learning.

1. Self-Evaluation: In an LMS, offering self-assessment to students can give them more confidence in what they are learning and decrease the effort for the lecturer. It can also provide them with a better approach to evaluation without the elements of exam stress, such as time constraints or nervousness.

2. Online Grading Feature: The grading system is useful to show the level of students in a course, and it also helps by sending grades into the system to analyze student performance in a course and to determine the course level.

3. Transcripts and Certificates: Another real-world simulation is the transcript. It helps to give a measurement of how students performed in a course with the help of the grading system. The certificate is an excellent way to indicate that a student has finished and passed a course.

Category 9: Support Criteria

With this group of criteria, we covered the backing standards of which any LMS consists in order to remain in competition within a field. It includes the details about any software, which can vary from documentation to the community. This type of support is considered to be the nourishing source for it and prevents it from vanishing from the competition with other LMSs.

1. Software Documentation: As is the case for any software, an LMS requires having official information from its developing entity or organization. Those documents should be accurate regarding the information, and they have to be updated whenever there is an upgrade operation in the LMS.

2. User Manual: This type of documentation is for the user of the software so that he can find all the basics and software information about how to use a program efficiently. The manual can also contain a practical description and properties of the hardware required for the software.

3. Online Tutorials: These types of data are widely used the most because they are easy to follow, and many users prefer them due to their not overwhelming their time with searching within multiple other documentation data types. Such data can be either video or text files but containing clarifications about the functionality of a program and how to use it properly.

4. Answers to Frequently Asked Questions: FAQs are the sections where one can find answers to common questions about the software which often appear routinely due to common problems or features in a program. Such questions might be repeated many times, and it is the first place where a user can seek answers. The section decreases the amount of time consumed for the user to ask and obtain any acknowledgment for a specific issue about the software.

Category 10: Course Management Criteria

As we move through the criteria, there is one standard that scores high in our survey among the others in the management criteria and represents a direct connection between the tutor and the course in front of the students in the course.

1. Participant control for online courses: Managing the interconnections through a course from the teacher over the student is an important factor. It gives more freedom to students to explain their ideas and their understanding during a session, which also helps the teacher to move faster while guaranteeing that students are educated in class acquiring a full understanding of any details and information. Moreover, it also makes constraints that avoid chaotic situations among students by controlling the space for explanation and time for students to interrupt their learning and explain their ideas.

3.1.2 Expert Survey


The experiments we used in our study were collected by using an online survey and invited experts to evaluate the criteria suitable for the final decision of selecting the LMS. A purposeful sampling methodology was used for the selection process of the participants. In this study, a purposeful sampling strategy was employed because this strategy can be used to decrease the range of variables related to the opinions of different participants in order to concentrate on the similarities [49]

This strategy performs quantitative measures, such as calculating the mean of each item in the research survey. According to the recommendations in [49], we considered the qualifications of the participants in terms of specific experience in instructional technologies to address the candidate criteria and maximize the efficiency and validity of the research aims. Therefore, the target participants for the survey were educational technology experts from the Computer Education and Instructional Technology departments of the universities in Turkey since they are the primary decision-makers during the LMS selection process. The first survey we conducted was for the selection of the preferable criteria by the experts according to their knowledge and experience.

They are asked to rate each criterion according to its importance. We sent 400 invitations to Computer Education and Instructional Technology department members in universities in Turkey. Twenty-six filled out our survey. Table 3.1 shows the demographics for 26 educational technology experts who shared their opinions in the published survey:

Table 3.1 Information about participants in our survey

Gender		Expertise Level	Number of Participants
Male	Female		
15	11	University	2
		Master	1
		PhD	23
		Total	26

Which of the following best describes your current occupation? 

26 responses

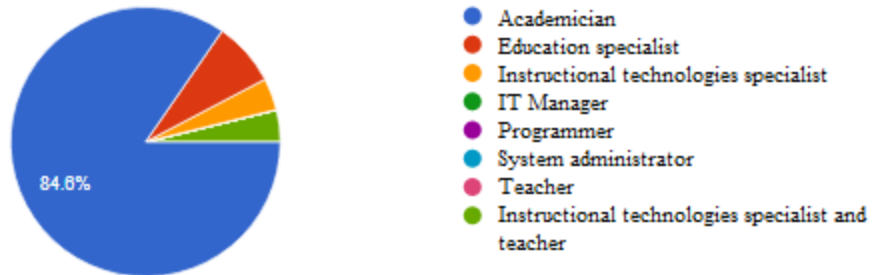


Figure 3.2 Information about participants in our survey

The survey has a scaling system consist of five alternatives: “Not Important at All,” “Little Important,” “Average Important,” “Very Important,” and “Absolutely Essential.” The system scoring starts from 0 and ends with 4 (See Table 3.2).

Table 3.2 Survey scale

Importance Scale	Equivalent Numerical Value
Not important at all	0
Little importance	1
Average importance	2
Very important	3
Absolutely essential	4

After applying the survey, the mean value for each criterion was calculated and analyzed. If the average for a criterion is greater than 3 (out of 4), this criterion was considered as a criterion in the study. If the average for a criterion is less than 3, this criterion was not considered in the comparison model, and all criteria in this degree were marked as Not Important (N.I.) and dropped. For example, Ease of Installation is a criterion considered in the study as a criterion because its average [27] fulfills the condition. Figure 3.2 shows statistics for the criterion mentioned above by 26 Educational Technology Experts. The averages for all candidate criteria were calculated and analyzed based on the same individual statistics (See Appendix E).

Evaluation criteria for learning management systems

1. Criteria for system management

1-Ease of installation (easy installation of software without effort or effort)

26 responses

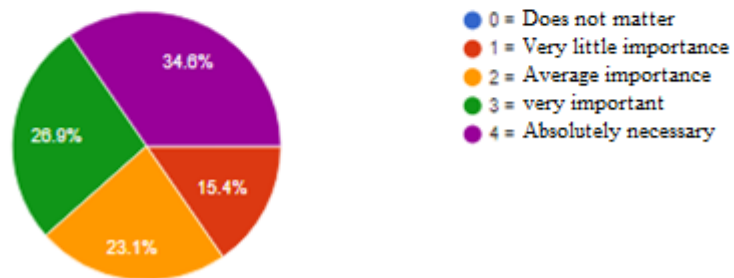


Figure 3.3 Survey questions

3.2 Test and Evaluation

In the second stage, we installed the LMSs and tested them to provide the final updates and compare the availability of the features in the final versions of the LMSs. The survey results would focus on the functionality of the LMS rather than the general and support criteria. In accordance with this result, we used the technical features of an LMS as criteria and tested them with all the LMS products. The test was conducted against the Moodle Version 3.5, Sakai's current version of the Sakai project is 11, and exporting the desired OpenedX version installed on the live servers. This test aims to perform a functional analysis for each system, i.e., how a system performs a specific criterion such as depending on a core feature “Built-in”, or whether the system needs to be extended with a third-party-extension “Plug-ins”. Later, each system was evaluated according to how a system performs the criteria.

Moreover, the grading mechanism we used to calculate the score is by referencing a number to a criterion. If the criteria are supported we give 2 score, if the criteria supported but as Extension we give 1 score, finally, if the feature is not existing we give 0 score.

Table 3.3 Criteria Scoring

Type	Points
Built-in	2
Extension	1
Not-supported	0

CHAPTER 4

IMPLEMENTATION AND RESULTS

4.1 Introduction

In this chapter, we provide a report about all the Learning Management Systems we mentioned earlier in chapter three. The report will cover all the criteria that have been collected and selected from a survey that we made, and many participants share their experiences with each of those criteria. The criteria have classified into primary groups, and inside each group, there will be sub-criteria. The comparison covered many points, and the result will collect and calculate all the available features and assign the value as the result of the comparison for the LMS. First, we made an Evaluation to choose the optimum criteria among numerous metrics we selected for the test

Among all the criteria we made, several of them dropped from the benchmark because it is unessential and scored low in the survey. In the survey, the number of participants reached 26 persons, and their expertise level varies from a university student to a lecturer in the university.

4.2 Results

After the selection of criteria according to the users' survey, we managed to perform in-depth searches in each category and compare all the LMSs and check which among them is better in each sub-category. The result contrasted from each group and showed the weak points of each LMS and covered the strong points of each one. The values varied from one group to another. The results are explained in the sections below. The grading system differs from the previous survey.

Here, we used a ranking system from 1 to 3 commensurate with the level of satisfaction in each system such that a low number represents a low level of satisfaction and the upper hand is for the value 3. Later, we counted the totals of the results we gained from each criterion to determine which LMSs scored higher. The only points that we have not covered in the points system were the difficulty of installation and the installation time from the system management standard because it is difficult to associate the time or the level of installation difficulty to a number.

4.3.1 System Management Criteria

In this group of criteria, as can be seen in the table below, we find that the installation complexity differs markedly from one LMS to another. The easiest among them was *Moodle* and the complicated installation scored by SAKAI with more than 300 packages of dependency, while OpenedX scored an average complexity. This point is counted for the Moodle LMS [1]. The installation time was also the same as the complexity regarding the results. The only difference here was the small gap in time between OpenedX and SAKAI. Identically with the first criteria, Moodle is the fastest installing LMS. All the LMSs supporting several operating systems, including Windows and Linux, with the exception of SAKAI, which is required to be installed on Linux as being preferred to overcome the problem that might appear with other operating systems. The update is higher in Moodle the others and is performed rapidly in Moodle, at an average speed for OpenedX and rarely for SAKAI, which might require the newest version to be installed every time with data backup. For upgrading, both Moodle and OpenedX offering functional upgrades for the system and they cover all current security issues and supply their systems with new features to keep pace with the competition in the market in front of other LMSs.

The user interface is easy to use in both Moodle and OpenedX; however, it dramatically lacks in SAKAI due to its having scored the lowest. The tables below illustrate the details about the score for each criterion and the rate of importance. We have not included the standards that do not have a score, such as ease of installation and the installation time. See Table 4.3.1

Table 4.3.1 System Management Criteria Scores

System Management Criteria					
	Criterion	Importance	MOODLE	OpenedX	SAKAI
1	Ease of Installation	A.E.	Easy	Average	Hard
2	Installation Time	A.I.	25 min	40-45 min	50 min
3	OS Compatibility	A.I.	All	All	All
4	System Update Feature	A.I.	3	2	1
5	Maintenance and Upgrading	V.I.	3	3	1
6	Application Programming Interface	V.I.	3	3	1
Total			9	8	3

Table 4.3.2 System Management Importance Rate Scores

	Criterion	Importance	Importance Rate
1	System Update Feature	A.I.	3.12
2	Maintenance and Upgrading	V.I.	3.27
3	Application Programming Interface	V.I.	3.38

4.4 Reliability Criteria

In this part, we find a variation in the performance of each LMS. First, the backup and recovery are the best in Moodle with full recovery for the information and databases and the materials of the course as well as a standard recovery of user information and databases in OpenedX and weak recovery for only the database in SAKAI. Error-prone *Moodle* appears not to have scored high in terms of errors throughout the test and has been doing with the companies, and no error-prone scored. With the limitation of features and the style of the system with constraints, OpenedX showed a few errors due to the boundaries of communication with the system for the users. SAKAI appears to lack many features in many of the criteria; however, it works flawlessly and never scored any error and returned the open source technology which provides more freedom to users. Finally, for correctness, all three systems showed the right amount of correctness indistinguishable from one another, as presented in the Table 4.4.1.

Table 4.4.1 Reliability Criteria Scores

Reliability Criteria					
	Criterion	Importance	MOODLE	OpenedX	SAKAI
1	Backup and Recovery Feature	A.E.	3	2	1
2	Error Prone	A.I.	3	1	2
3	Correctness	A.E.	3	3	3
Total			9	6	6

Table 4.4.2 Reliability Criteria Importance Rate Scores

Criteria		Importance	Importance Rate
1	Backup and Recovery Feature	A.E.	3.73
2	Error Prone	A.I.	3.65
3	Correctness	A.E.	3.61

4.5 Usability Criteria

For usability criteria, we only used one standard, which was the supporting of the current web browser. We produced the result that every LMS supports most current web browsers. We tested the usability criteria on Mozilla Firefox and Google Chrome, which are the main browsers in the current time and which most people prefer to use because of the stability and reliability and performance of those browsers.

Table 4.5.1 Usability Criteria Scores

Usability Criteria								
	Criterion	Importance	MOODLE		OpenedX		SAKAI	
1	Support Existing Browsers	A.E.	Built-in	2	Built-in	2	Built-in	2
Total			2		2		2	

Table 4.5.2 Usability Criteria Importance Rate Scores

Criteria		Importance	Importance Rate
1	Support Existing Browsers	A.E.	3.53

4.6 Learning Analysis Criteria

Similarly, for the reliability criteria, we found that every LMS offers reporting features for the student with all the details required for analysis of their progress during sessions. Additionally, all three LMSs provide a time analysis feature to observe the performance inside the course and in the system. Therefore, every LMS scored satisfactorily and received the same results in this criterion.

Table 4.6.1 Learning Analysis Criteria Scores

Learning Analysis Criteria								
	Criterion	Importance	MOODLE		OpenedX		SAKAI	
1	Providing Reports about Student Progress	A.E.	Built-in	2	Built-in	2	Built-in	2
2	Time Analysis Feature	V.I.	Built-in	2	Built-in	2	Built-in	2
Total			4		4		4	

Table 4.6.2 Learning Analysis Importance Rate Scores

Criterion		Importance	Importance Rate
1	Providing Reports on Student Progress	A.E.	3.38
2	Time Analysis Feature	V.I.	3.03

4.7 Security and Privacy Criteria

Nowadays, the security issue is critical, and it affects all software around the world. We covered five main features in our work, depending on the results we gained from the survey, and all of the criteria scored the highest importance level. All three LMSs have a validation input feature and support a range of different users and have encryption for documents. Moodle and OpenedX support SSL while SAKAI requires the installation of the extension. Moreover, the email verification feature is also lacking in SAKAI, but it is provided as an extension, as shown in the Table 4.7.1.

Table 4.7.1 Security and Privacy Criterion Scores

Security and Privacy Criteria								
	Criterion	Importance	MOODLE		OpenedX		SAKAI	
1	Different User Types Support	A.E.	Built-in	2	Built-in	2	Built-in	2
2	Validation of input feature	A.E.	Built-in	2	Built-in	2	Built-in	2
3	Data/Document Encryption Feature	A.E.	Built-in	2	Built-in	2	Built-in	2
4	(SSL) Certificate Layer Support	A.E.	Built-in	2	Built-in	2	Extension	1
5	Email Verification Feature	A.E.	Built-in	2	Built-in	2	Extension	1

Table 4.7.2 Security and Privacy Importance Rate Scores

	Criteria	Importance	Importance Rate
1	Different User Types Support	A.E.	3.42
2	Validation of Input Feature	A.E.	3.46
3	Data / Document Encryption Feature	A.E.	3.38
4	(SSL) Certificate Layer Support	A.E.	3.61
5	Email Verification Feature	A.E.	3

4.8 Communication Criteria

The communication criteria covered crucial features used in learning as modern technology. The result here was dissimilar to the previous tests. SAKAI scored the highest by including every communication criterion. Moodle scored the second-highest because it lacked video conferencing and whiteboard features which were only available as extensions. OpenedX scored the lowest here because it has an extension for the forum. Additionally, OpenedX does not provide whiteboard features, and it did not support extensions until we performed the tests. One last issue related to the OpenedX is that it lacks a file-sharing feature between students due to the teaching mechanism inside it, which is similar to a private tutor for a single student in a real-life example. The results are presented below in Table 4.8.1.

Table 4.8.1 Communication Criterion Scores

Communication Criteria								
	Criterion	Importance	MOODLE		OpenedX		SAKAI	
1	LIVE Video Conferencing	A.E.	Extension	1	Built-in	2	Built-in	2
2	Direct Communication Feature	A.E.	Built-in	2	Built-in	2	Built-in	2
3	Forum Feature	A.E.	Built-in	2	Extension	1	Built-in	2
4	Whiteboard	V.I.	Extension	1	Not-supported	0	Built-in	2
5	File Sharing	A.E.	Built-in	2	Not-supported	0	Built-in	2
Total			8		5		10	

Table 4.8.2 Communication Criteria Importance Rate Scores

	Criteria	Importance	Importance Rate
1	LIVE Video Conferencing	A.E.	3.30
2	Direct Communication Feature	A.E.	3.26
3	Forum Feature	A.E.	3.03
4	Whiteboard	V.I.	3.07
5	File Sharing	A.E.	3.30

4.9 Authorship Tools Criteria

All the LMSs covered most of the standards and shares with missing activities inside the class. These require extensions to be installed for both Moodle and OpenedX; however, this is not supported in SAKAI. With the exception of SAKAI, the same result is duplicated with the YouTube integration feature. SAKAI lacks support for the YouTube integration feature. The results, as shown in Table 4.9.1, are the same results for Moodle and OpenedX and low for SAKAI.

Table 4.9.1 Authorship Tools Criterion Scores

Authorship Tools Criteria								
	Criteria	Importance	MOODLE		OpenedX		SAKAI	
1	Linking	V.I.	Built-in	2	Built-in	2	Built-in	2
2	Create/Delete Courses	A.E.	Built-in	2	Built-in	2	Built-in	2
3	Upload-Download Resource Packages	A.E.	Built-in	2	Built-in	2	Built-in	2
4	Course Template	A.E.	Built-in	2	Built-in	2	Built-in	2
5	Interactive Activities During the learning	A.E.	Extension	1	Extension	1	Not- supported	0
6	Online Quiz Editor	V.I.	Built-in	2	Built-in	2	Built-in	2
7	YouTube Integration	V.I.	Extension	1	Extension	1	Not- supported	0
Total			12		12		10	

Table 4.9.2 Authorship Tools Criteria Importance Rate Scores

	Criterion	Importance	Importance Rate
1	Linking	V.I.	3.19
2	Create/Delete Courses	A.E.	3.73
3	Upload-Download Resource Packages	A.E.	3.53
4	Course Templates	A.E.	3.11
5	Interactive Activities During Learning	A.E.	3.26
6	Online Quiz Editor	V.I.	3.11
7	YouTube Integration	V.I.	3

4.10 Evaluation Criteria

In this part, every LMS provides very feature except for those in the transcripts and certification criteria. Surprisingly, Moodle scored low, similarly to SAKAI. Both do not provide transcripts as a built-in feature. An extension in the system is required to obtain this feature while in OpenedX, it is the central part of the LMS and provides good design for this task. The results for this criterion are shown in the Table 4.10.1.

Table 4.10.1 Evaluation Criteria Scores

Evaluation Criteria								
	Criterion	Importance	MOODLE		OpenedX		SAKAI	
1	Self-Evaluation	A.E.	Built-in	2	Built-in	2	Built-in	2
2	Online Grading Feature	A.E.	Built-in	2	Built-in	2	Built-in	2
3	Transcripts and Certificates	A.E.	Extension	1	Built-in	2	Extension	1
Total			5		6		5	

Table 4.10.2 Evaluation Criteria Importance Rate Scores

	Criteria	Importance	Importance Rate
1	Self-Evaluation	A.E.	3.15
2	Online Grading Feature	A.E.	3.15
3	Transcripts and Certificates	A.E.	3.07

4.11 Support Criteria

In this section, all the LMSs gained the same result with the full support of the features in the criteria. They offer documentation to users and descriptions about the software as manuals. Moreover, they had online tutorials, even with few but adequate resources for SAKAI. Finally, the systems had the same answers as any standard software FAQ answers. In the Table 4.11.1, it can be observed that every LMS yielded the same result.

Table 4.11.1 Support Criteria Scores

Support Criteria								
	Criterion	Importance	MOODLE		OpenedX		SAKAI	
1	Software Documentation	A.E.	Built-in	2	Built-in	2	Built-in	2
2	User Manual	A.E.	Built-in	2	Built-in	2	Built-in	2
3	Online Tutorial	A.E.	Built-in	2	Built-in	2	Built-in	2
4	Answers to Frequently Asked Questions	V.I.	Built-in	2	Built-in	2	Built-in	2
Total			8		8		8	

Table 4.11.2 Support Criteria Importance Rate Scores

	Criterion	Importance	Importance Rate
1	Software Documentation	A.E.	3.11
2	User Manual	A.E.	3.46
3	Online Tutorial	A.E.	3.03
4	Answers to Frequently Asked Questions	V.I.	3.03

4.12 Course Management Criteria

The ability to control students and users inside a course scored as an absolute essential in our first survey, among others in the course of managing criteria. After we observed every LMS, we concluded that every LMS provides the same level of control over participation.

Table 4.12.1 Course Management Criteria Scores

Course Management Criteria								
	Criterion	Importance	MOODLE		OpenedX		SAKAI	
1	Participant Administration for Online Courses	A.E.	Built-in	2	Built-in	2	Built-in	2
Total			2		2		2	

Table 4.12.2 Course Management Criteria Importance Rate Scores

Criteria		Importance	Importance Rate
1	Participant Administration for Online Courses	A.E.	3.19

4.13 Final Result

The Moodle LMS scored higher than the others in terms of management and reliability. Then it fluctuates from the security through to the communication criteria until the support criteria. OpenedX scored nearly identically to Moodle and surpassed SAKAI in several criterion groups. The only standard when SAKAI surpassed the other LMSs was in the communication criteria. In other words, Moodle scored highest among all the LMSs used in this work, followed by OpenedX and finally SAKAI. For the screenshots for each criterion taken from all the LMSs see Appendix (B, C, D)

Table 4.13. Total scores for all criteria

All Criteria		MOODLE	OpenedX	SAKAI
1	System Management Criteria	9	8	3
2	Reliability Criteria	9	6	6
3	Usability Criteria	2	2	2
4	Learning Analysis Criteria	4	4	4
5	Security and Privacy Criteria	10	10	8
6	Communication Criteria	8	5	10
7	Authorship Tools Criteria	12	12	10
8	Evaluation Criteria	5	6	5
9	Support Criteria	8	8	8
10	Course Management Criteria	2	2	2
Total Score		69	63	58

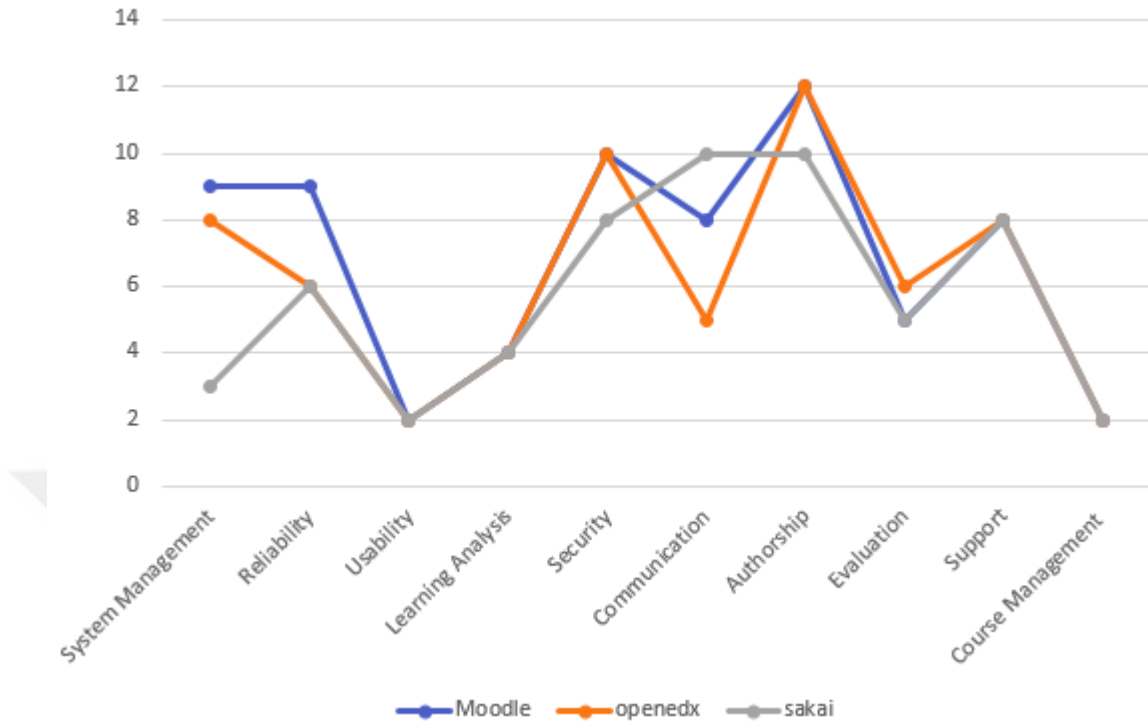


Figure 4.1: LMS final score in each group of criteria

For usability, we found that most users were satisfied with all the LMSs included in the research with partial variety in the score for each LMS due to user preferences. Moodle scored the highest here followed by OpenedX and finally SAKAI.

Table 4.14 Usability Criteria PSSQ Score for each LMS

Criterion	Moodle	SAKAI	OpenedX
1 Support Existing Browsers	4.57	4.1	4.26

We made this test by providing a satisfaction level for each LMS, and we gave it to the user. By using the LMS on several web browsers, they will measure and select their quality of using the LMS on those browsers that reflects their opinion. The scale consisted of 5 levels starting from 0, which represents the lowest satisfaction as "not satisfied" or five as "completely satisfied". By taking the result and averaging it with the number of users, we got the results in the Table 4.14.

Table 4.15 Participants Scale

Overall I am satisfied with using the LMS on Different Web Browsers						
Strongly Disagree	1	2	3	4	5	Strong Agree
Comments						

Table 4.16 Moodle PSSUQ Calculations

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	Mean
5	4	5	4	4	5	5	5	5	5	5	4	4	4.61

Table 4.17 OpenedX PSSUQ Calculations

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	Mean
4	4	5	4	4	4	5	5	4	4	5	4	5	4.38

Table 4.18 SAKAI PSSUQ Calculations

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	Mean
3	4	4	3	4	4	5	5	5	4	3	4	5	4.07

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 Conclusion

In our study, we focused on three open-source Learning Management Systems. Those systems are the, namely Moodle, OpenedX and SAKAI. We presented those three systems in detail and collected all the possible data considered to be the main factors in a new comparison to help users to select from them regarding their (users') demands. We covered several groups or criteria according to many research papers and previous studies [5] [50] [7]. First, we installed the LMSs and tested them. Later, we surveyed after collecting all the possible features that might be important for several people. We presented the survey to experts and students at universities (approximately 400 people). Then we took the standards that scored highly in terms of importance. We ordered them in groups and started experimenting on the LMS.

In this work, we made several criteria that uncovered in work [6] [17] [18].The comparison covered more open Source Learning Management Systems and compared these systems with criteria with higher availability regards the user need [36].In the technical part, this work showed a stable performance for the LMS used in the research, and the ranking remains stable as the previous works [10] [19]. The features of both OpenedX and Moodle has improved with a partial and very limited enhancement in SAKAI due to the several updates in the mentioned above LMSs. This study included a comparison between LMSs than has not been done by other research such as [20].

In the phase, we checked each platform to determine whether it contained the feature and the amount of satisfaction we could obtain from using it should it be available. The result varied from one group to another.

In the system management criteria, Moodle scored the highest followed by OpenedX and finally SAKAI. The results here were obtained by comparing the features associated with the general management of the LMS, which also consisted of the installation and the main criteria that attracted people as the main points in any comparison between LMSs. Installation was easy and less complicated and consumed less time than the others. Both Moodle and OpenedX were compatible with most operating systems. SAKAI scored the lowest in all the features in this group of criteria. We can conclude that in terms of system management that *Moodle* is the best of the three under examination.

The same result applies to Moodle in the reliability criteria with the same score being shared between OpenedX and SAKAI. The only difference here was error-prone, which was more accurate with *Sakai* than with OpenedX.

In the usability criteria, the results were identical between every LMS. All were supported by every Internet browser in the current time. Testing was performed on three web browsers, namely Internet Explorer, Google Chrome, and Mozilla Firefox.

The same results appeared in the learning analysis group, and every feature existed in every LMS. In the security issue, Moodle and OpenedX scored identically; however; two features were lacking in SAKAI, namely the SSL and the email verification as built-in features. However, these features were available as extensions that would need to be installed inside the LMS.

The result was completely different in the communication criteria, where OpenedX scored the lowest due to it missing the whiteboard feature and there being no extension from trusted sources for it or at least be supported by the SAKAI Project. Next was Moodle, which required extensions to obtain video conferencing communication and the whiteboard. On the other hand, SAKAI scored the highest by including every feature as being built-in.

In the authorship criteria, the results were identical, even in the features for both Moodle and OpenedX. Moreover, there was a lack of support for several features in SAKAI. For example, there was no YouTube extension, and it was a requirement to upload videos as external sources. Moreover, there was a lack of interactivity inside the class using the activities.

For the evaluation criteria, OpenedX scored the highest here with full built-in features and extensions for other features. The result was identical for Moodle and SAKAI with extensions to include transcripts and certificates.

There was full support for every LMS, and this return to the open-source software communities and the support varied from the documentation until the Frequently Asked Questions and their answers. Every LMS scored identically here. Finally, the course management criteria were identical for every LMS such that every LMS had built-in features with no need for extensions with full manipulation inside the class.

5.2 Future Work

For future work, we are going to include new features and compare them with current features and determine whether there will be an improvement. We will produce our scoring system by building software to test each LMS separately and by testing the logging, especially the security issues with new risks appearing every day requiring continuous checking and testing to overcome them.

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APPENDIX A

INSTALLATION SECTION

Since the installation is an essential part of the software usage, and due to the complexity, that might come with some installation, we have seen that providing an overview about installation is better idea. to understand the level of difficulty of each software in term of installation to make give a better view for the setup of each LMS.

Setting the environment

To install the LMSs, there is a need to set up the environment to be able to handle the LMS demands. First, there is a need to install an Apache Server on the Linux-Based operating system. We will provide the installation with the command that can be executed with the terminal. To install the Apache server, we can install it with the following command:

```
sudo apt-get install apache2
```

Then, there is the MySQL database which is one of the widely used by web-based software and that return to the fact that it is fast. To install MySQL server for the database Management. It can be installed with the command:

```
sudo apt-get install MySQL-server
```

Also, the PHP should be installed with the packages associated with it with the command:

```
sudo apt install php-pear php-fpm php-dev php-zip php-curl php-xmlrpc php-gd php-  
mysql php-mbstring php-xml libapache2-mod-php
```

To make sure that the Apache server worked in good shape and took all the update the service responsible for it need to be restarted with the command:

```
sudo service apache2 restart
```

After restarting the apache server, to check if its installed or not by opening the browser. Like the Figure A.1.

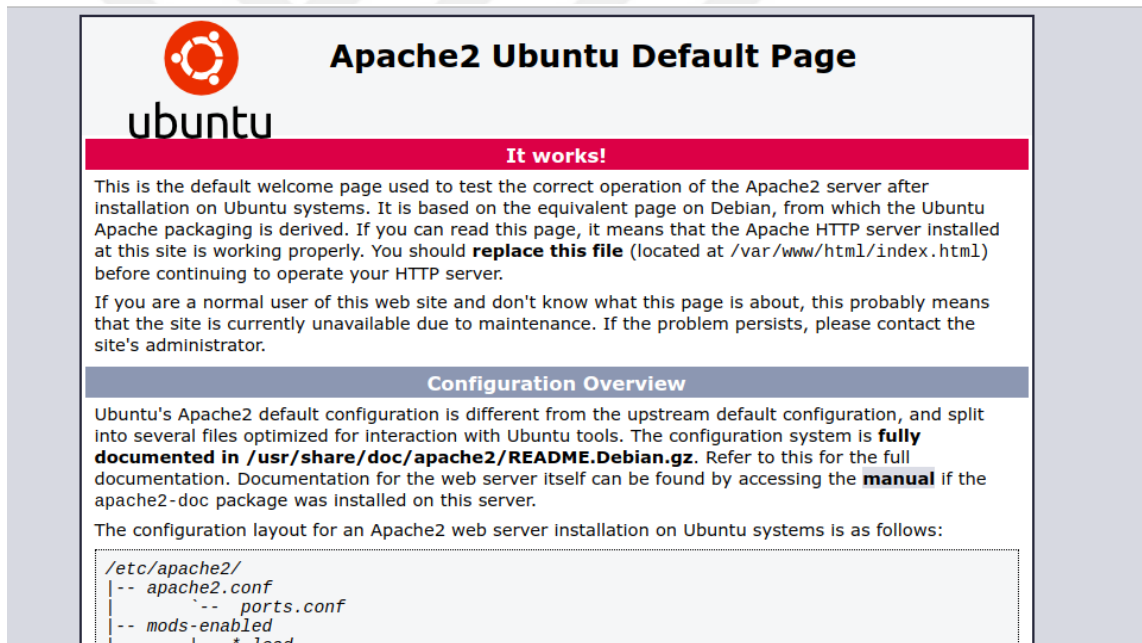


Figure A.1: Apache proof of working notification page

Finally, to check the PHP by running the command below in terminal and the expected message is "**Your PHP installation is working fine.**":

```
php -r 'echo "\n\nYour PHP installation is working fine.\n\n\n";'
```

1. Moodle Installation

The Moodle LMS used in this study is the version 3.5 it can be downloaded from the link below which provide the latest stable version of Moodle from the official website. Then, after extract it the extracted folder needs to be moved to the destination folder whether on a server or local machine. After that, an empty database should be created to hold the user data. This database should contain the following information:

- **Dbhost:** the name of the local host
- **Dbname:** the database name
- **Dbuser:** the username that will be used to manipulate the database
- **Dbpass:** the password for the database user

When login for the first time by the web browser the user will face the first installation page which requires to configure the setup language and the language that will be used as the default language of use in the Moodle LMS. Figure (A.2). After choosing the language, the confirmation the data paths for Moodle and the data associated to need to be set. Figure (A.3)

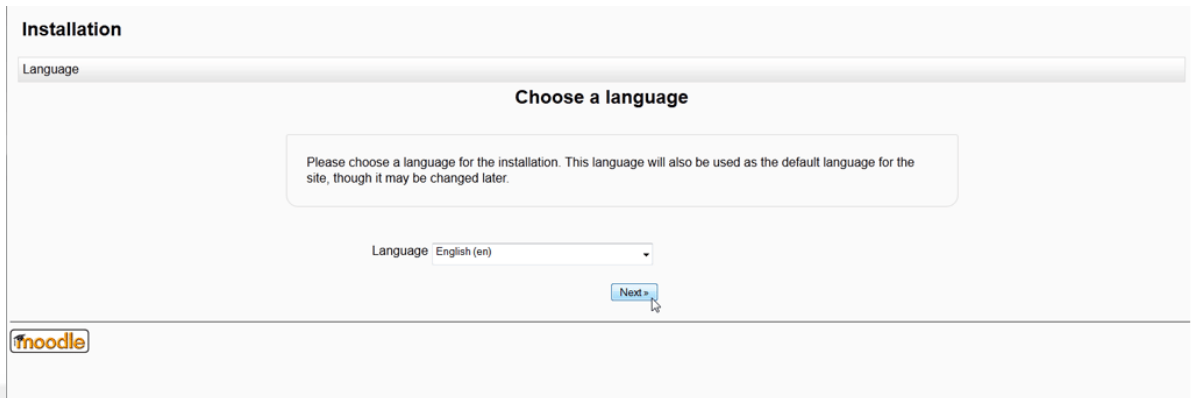


Figure A.2: Moodle Language Selection page

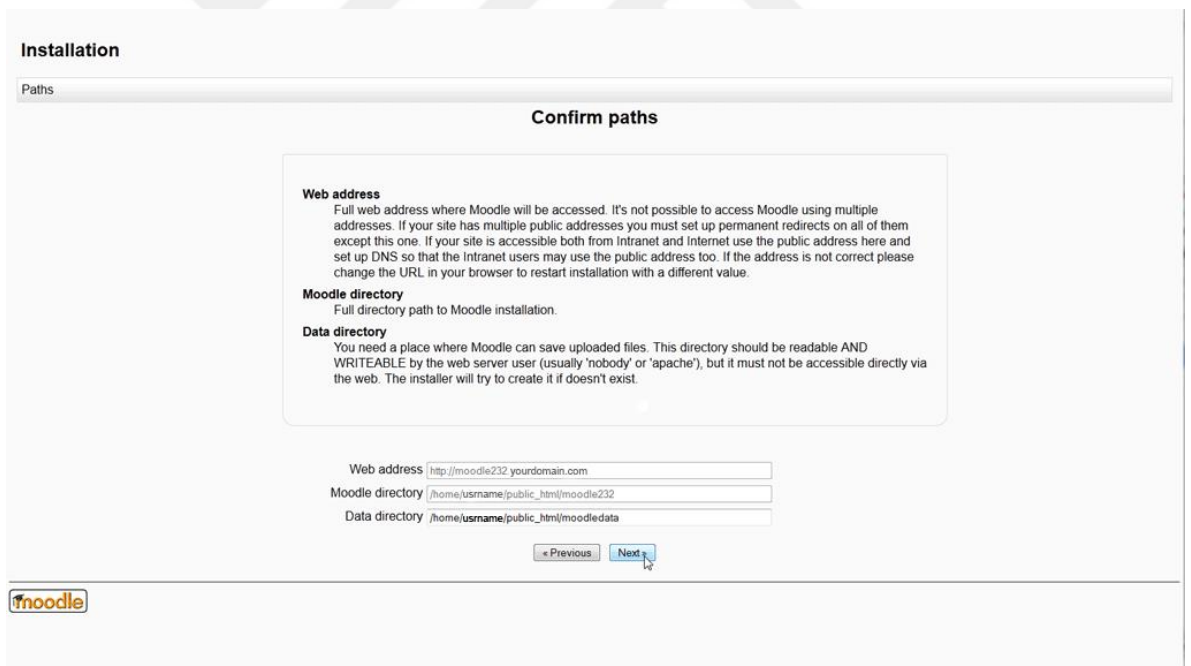


Figure A.3: Paths Confirmation Page

The next step is choosing the database type. The Moodle LMS supports various database driver to work on such as PostgreSQL and MySQL and Oracle. In this study, all the LMS will be depended on the MySQL database Driver as the primary database of the LMS. Figure (A.4)

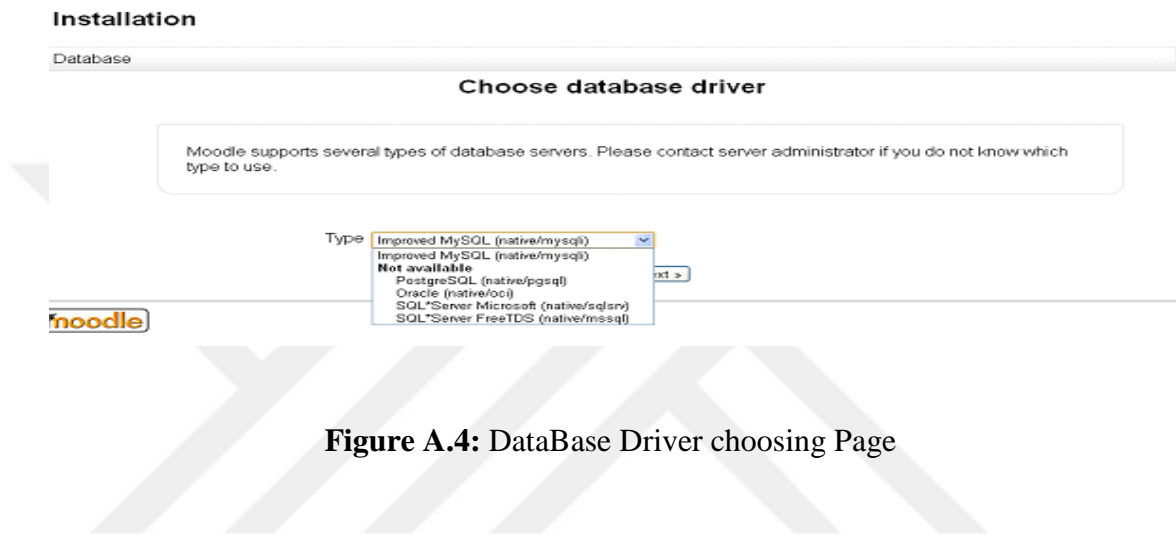


Figure A.4: DataBase Driver choosing Page

DataBase Driver choosing Page

The next step is creating a database with the MySQL driver and fill the related information. This database is the user will use the default database. However, since the database already have been created. The previous database will be linked to this page and make it the default database figure (A.5). The next page will be the copyright use for Moodle Figure (A.6).

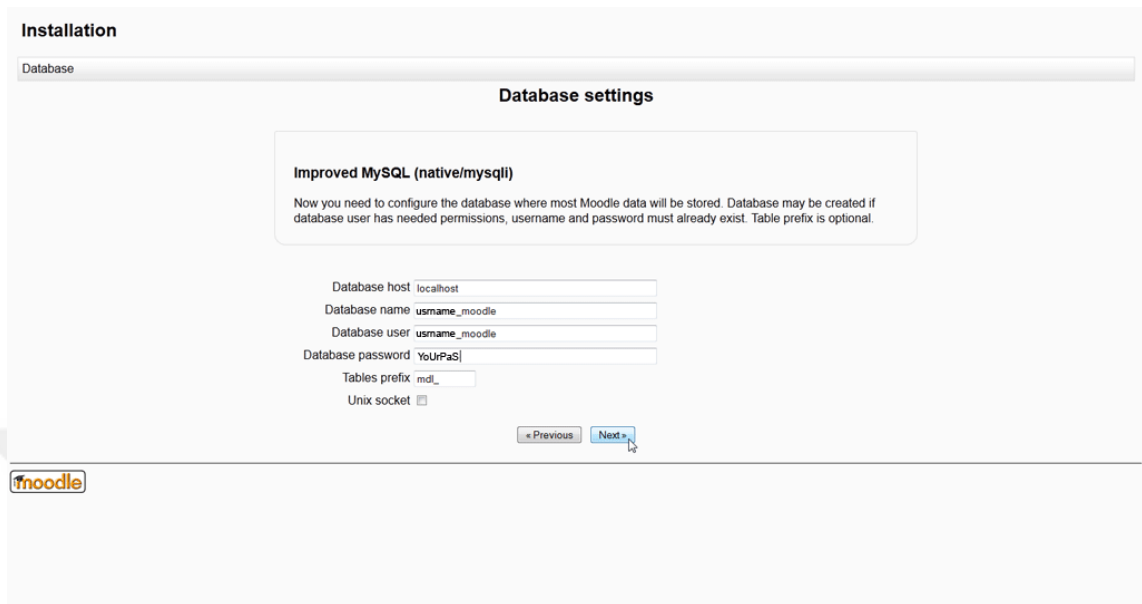


Figure A.5: Data Base settings page

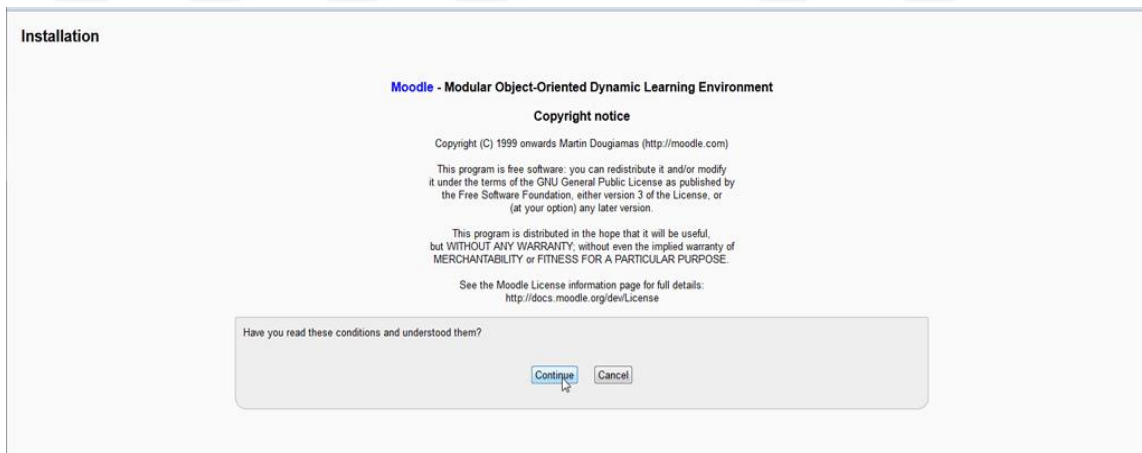


Figure A.6: Moodle Copyright page

The server will check for all the requirements needed to start the last installation and gives notifications about the past checks and whether we need to install any missing or incompatible software. This procedure helps to give full coverage for most of the dependencies and the software installed in the operating system. This will help in case

there is a missing package or an old version of the package that it might not be compatible with the Moodle LMS. Figure (A.7).

For information about this version of Moodle, please see the online [Release Notes](#)

Server checks

Name	Information	Report	Status
php_extension	mbstring	<ul style="list-style-type: none"> should be installed and enabled for best results Installing the optional MBSTRING library is highly recommended in order to improve site performance, particularly if your site is supporting non-Latin languages. 	Check
php_extension	xmldrpc	<ul style="list-style-type: none"> should be installed and enabled for best results The xmldrpc extension is needed for hub communication, and useful for web services and Moodle networking 	Check
php_extension	intl	<ul style="list-style-type: none"> should be installed and enabled for best results Intl extension is used to improve internationalization support, such as locale aware sorting. 	Check
unicode		<ul style="list-style-type: none"> must be installed and enabled 	OK
database	mysql	<ul style="list-style-type: none"> version 5.1.33 is required and you are running 5.1.63 	OK
php		<ul style="list-style-type: none"> version 5.3.2 is required and you are running 5.3.17 	OK
pcrunicode		<ul style="list-style-type: none"> should be installed and enabled for best results 	OK
php_extension	iconv	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	curl	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	openssl	<ul style="list-style-type: none"> should be installed and enabled for best results 	OK
php_extension	tokenizer	<ul style="list-style-type: none"> should be installed and enabled for best results 	OK
php_extension	soap	<ul style="list-style-type: none"> should be installed and enabled for best results 	OK
php_extension	ctype	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	zip	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	gd	<ul style="list-style-type: none"> should be installed and enabled for best results 	OK
php_extension	simplexml	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	spl	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	pcrc	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	dom	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	xml	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	json	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_extension	hash	<ul style="list-style-type: none"> must be installed and enabled 	OK
php_setting	memory_limit	<ul style="list-style-type: none"> recommended setting detected 	OK
php_setting	safe_mode	<ul style="list-style-type: none"> recommended setting detected 	OK
php_setting	file_uploads	<ul style="list-style-type: none"> recommended setting detected 	OK

Your server environment meets all minimum requirements.

Figure A.7: server dependency checking page

The next is the administrator information which consists of the user information and the database and the contacting information to receive all the messages related to the LMS. All the information related to the user courses will be received in the registered email. Also, it is good to receive feedback and the course notifications through the emails. Figure (A.8). Then the front-page settings page will appear next, and it can be passed and configure it later figure (A.9). Moreover, the last page is to finalize the installation by saving the changes and moving the user interface for the Moodle LMS figure (A.10).

Installation You are logged in as Admin User (Logout)

On this page you should configure your main administrator account which will have complete control over the site. Make sure you give it a secure username and password as well as a valid email address. You can create more admin accounts later on.

General

Username*

Choose an authentication method Manual accounts

The password must have at least 8 characters, at least 1 digit(s), at least 1 lower case letter(s), at least 1 upper case letter(s), at least 1 non-alphanumeric character(s)

New password* Unmask

Force password change

First name*

Surname*

Email address*

Email display

Email format

Email digest type

Forum auto-subscribe

When editing text

Screen reader

City/town*

Select a country*

Timezone

Preferred language

Description

Moodle auto-format

Optional

Web page

ICQ number

Skype ID

AIM ID

Yahoo ID

MSN ID

ID number

Institution

Department

Phone

Mobile phone

Address

There are required fields in this form marked *.

Figure A.8: user information entry page

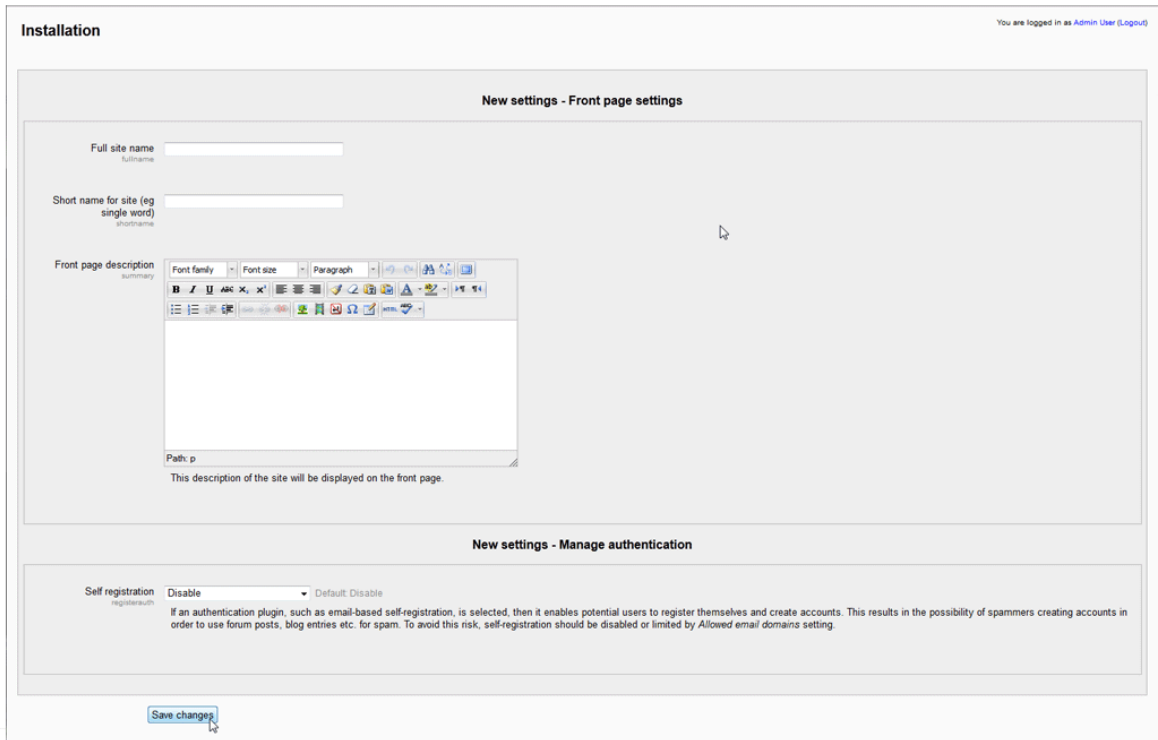


Figure A.9: Front page settings page

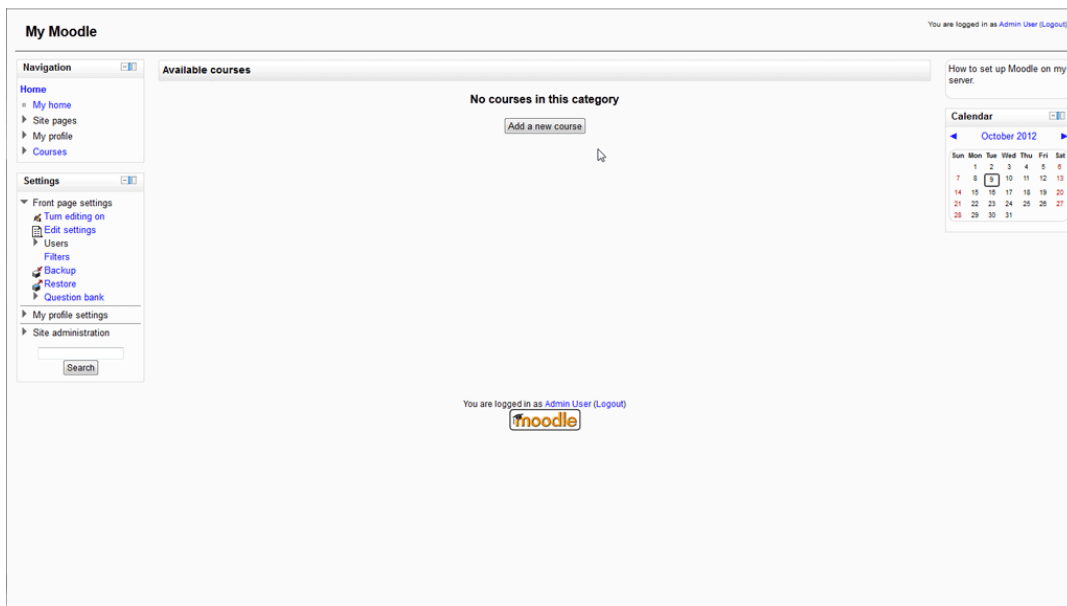


Figure .10: Front page of the Moodle main user interface

2. Installation of OpenedX

To install openEDX, it requires to run only four commands in terminal. First thing is exporting the desired OpenEDX version. Moreover, to know which version the user can visit and copy the Git Tag for the version. In this work the latest version is Ginkgo. 2 and the Git Tag associated with is "open-release/ginkgo.2". The second command is for collecting the bootstrap for the OpenEdx version. The third command is to reset the password for the new installations. The fourth and last command is for installing the OpenEDX. After finishing the installation visit, 192.168.33.10 in the browser and the Sakai will run in the website figure (A.11).

```
export OPENEDX_RELEASE=open-release/ginkgo.2

wget
https://raw.githubusercontent.com/edx/configuration/$OPENEDX_RELEASE/util/install/ansible-bootstrap.sh -O - | sudo bash

wget
https://raw.githubusercontent.com/edx/configuration/$OPENEDX_RELEASE/util/install/generate-passwords.sh -O - | bash

wget
https://raw.githubusercontent.com/edx/configuration/$OPENEDX_RELEASE/util/install/sandbox.sh -O - | bash
```

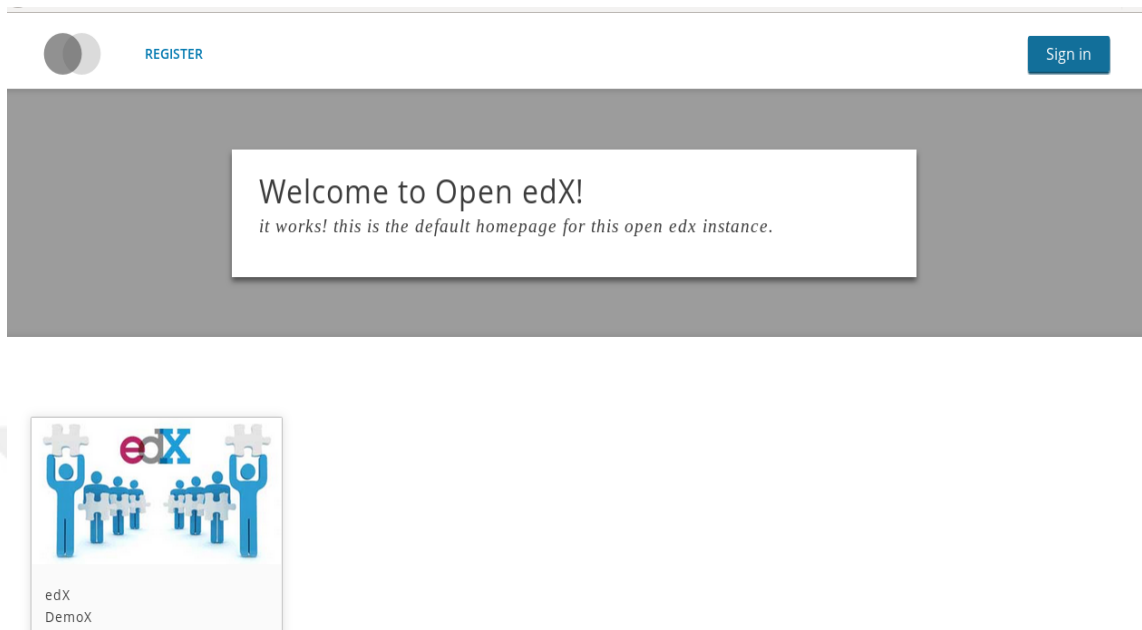


Figure A.11: OpenedX main Page

3. Installation of Sakai

Installing Sakai requires additional software like the other LMS. The current version of Sakai project is 11, and this version needs a new version of the following software: Git, Apache Maven, JDK (Java Development Kit), Apache Tomcat, MySQL and MySQL JDBC (Java Database Connector). The compatible version of that software for Sakai 11 are:

- Maven 3.2.3
- Java 1.8.0_77
- Tomcat 8.0.32
- MySQL 5.6.27
- MySQL JDBC jar 5.0.8

Step 1 Since the work has been done in Linux operating systems. The installation will be covered the setup procedures with the Linux OS only. Since then the Linux is an open source operating system, it requires some modifications to set the path for the dependencies in the bash file (~/.bash_login). The lines need to be added the: JAVA_HOME, which is the path for the JDK in system files, MAVEN_HOME, which is related to the maven files and CATALINA_HOME which is for the Tomcat files. To accomplish step 1, the lines below should be edited or added to the bash file.

JAVA_HOME	export JAVA_HOME=path-to-java
MAVEN_HOME	export MAVEN_HOME=path-to-maven
CATALINA_HOME	export CATALINA_HOME=path-to-tomcat
PATH	export PATH=\$PATH:\$JAVA_HOME/bin:\$MAVEN_HOME/bin:\$CATALINA_HOME/bin
MAVEN_OPTS	export MAVEN_OPTS='-Xms512m -Xmx1024m- java.util.Arrays.useLegacyMergeSort=true'

Step 2 Next, the database should be configured to work essentially with the Sakai. In the beginning, a database should be created. The database is associated with the Sakai user, the conclusion of this step is creating database name, user name, and password with the UTF8 Unicode.

```
mysql> create database lmsdb default character set utf8;
Query OK, 1 row affected (0.00 sec)

mysql> grant all on lmsdb.* to ahmed@'localhost' identified by 'ahmedlms';
Query OK, 0 rows affected (0.00 sec)
```

```
mysql> grant all on lmsdb.* to ahmed@'127.0.0.1' identified by 'ahmedlms';
```

```
Query OK, 0 rows affected (0.00 sec)
```

```
mysql> flush privileges;
```

```
Query OK, 0 rows affected (0.00 sec)
```

```
mysql> quit
```

Step 3 The third step is the Tomcat configuration. First, the MySQL JDBC file needs to be removed to the directory of CATALINA_HOME/lib. The next step is to create a directory for Sakai in the CATALINA_HOME to be CATALINA_HOME/sakai. In this directory create an empty file and name it as sakai.properties. In the Sakai properties, add the next lines:

```
## MySQL settings
```

```
username@javax.sql.DataSource=ahmed #whatever username you assigned in the  
database setup
```

```
password@javax.sql.DataSource=ahmedlms #whatever password you assigned to  
the sakaiuser in the database setup
```

```
# use your sakaidatabase name in the URI that starts url@javax.sql.DataSource =,  
below.
```

```
vendor@org.sakaiproject.db.api.SqlService=mysql
```

```
driverClassName@javax.sql.DataSource=com.mysql.jdbc.Driver
```

```
hibernate.dialect=org.hibernate.dialect.MySQL5InnoDBDialect
```

```
url@javax.sql.DataSource=jdbc:mysql://127.0.0.1:3306/sakaidatabase?useUnicode  
=true&characterEncoding=UTF-8
```

```
validationQuery@javax.sql.DataSource=select 1 from DUAL
```

```
defaultTransactionIsolationString@javax.sql.DataSource=TRANSACTION_REA  
D_COMMITTED
```


later, modify the context.xml in the CATALINA_HOME/conf directory by adding the lines below inside the <Context> tag to increase the speed of the startup for Sakai:

```
<JarScanner>
  <!-- This is to speedup startup so that tomcat doesn't scan as much -->
  <JarScanFilter defaultPluggabilityScan="false" defaultTldScan="false" tldScan="jsf-impl-*.jar,jsf-widgets-*.jar,myfaces-impl-*.jar,pluto-taglib-*.jar,sakai-sections-app-util-*.jar,spring-webmvc-*.jar,standard-*.jar,tomahawk*.jar,tomahawk-*.jar"/>
</JarScanner>
```

The next modification will be in the CATALINA_HOME/conf/server.xml. It is responsible about the international characters supporting. It requires to add:

```
<Connector port="8080" URIEncoding="UTF-8" >
```

the last modification will be in the CATALINA_HOME/bin directory. By creating a bash shell script and name it steven.sh and add the line below inside it:

```
export JAVA_OPTS='-server -Xms512m -Xmx1024m -XX:PermSize=128m -
XX:NewSize=192m -XX:MaxNewSize=384m -Djava.awt.headless=true -
Dhttp.agent=Sakai -
Dorg.apache.jasper.compiler.Parser.STRICT_QUOTE_ESCAPING=false -
Dsun.lang.ClassLoader.allowArraySyntax=true -
Djava.util.Arrays.useLegacyMergeSort=true -Dsakai.demo=true'
```

Step 4 Compiling the Sakai source code in the terminal by typing two commands. The first command is for getting the Sakai files from the official Git repository. The second one is to move to the Sakai directory and check the Git downloaded version of Sakai and whether it the latest version.

```
git clone https://github.com/sakaiproject/sakai.git
cd sakai && git checkout 11.2
```

After downloading the latest version of Sakai. The master project should be compiled with the following command, and the expected message of the execution is "Build Successful." Then execute the second commands to compile and deploy Sakai with Tomcat. Also, the message should be "Build Successful."

```
cd master
mvn clean install
```

```
cd ..
mvn clean install sakai:deploy -Dmaven.tomcat.home=$CATALINA_HOME -
Djava.net.preferIPv4Stack=true -Dmaven.test.skip=true
```

Step 5 In the next steps the user needs to start Sakai and make sure its work correctly. The test starts from the CATALINA_HOME/bin directory and running the startup.sh shell script. With the command in terminal:

```
./startup.sh
```

The last testing is checking the "catalina.out" log file CATALINA_HOME/logs. There should be a message about the starting up with the time of startup "system started up in seconds." If the message is there go to the web browser and type <http://localhost:8080> which is for the tomcat and there should be a message "Apache Tomcat page. Tomcat is running". The last thing is visiting <http://localhost:8080/portal>, and the expected result is Sakai running with welcome interface Figure (A.12).



user id: password:

Welcome **Message Of The Day**

[About](#) There are currently no messages at this location.

[Features](#)

[Site Browser](#)

[Training](#)

[Acknowledgments](#)

[New Account](#)

[Help](#)

Welcome!

Welcome to Sakai

Welcome to the Sakai Demo. The Demo configuration was created as a way to let you get an instance of Sakai up and running quickly and easily. For more information about installing a Sakai solution appropriate for production needs please read the readme files, and visit the Sakai website at sakaiproject.org, and the Sakai Developer's site at collab.sakaiproject.org.

The information displayed here can be modified by the Sakai Administrator by editing the file `sakai.properties` configuration value "server.info.url" to point to the html file desired.

Figure A.12: Sakai main page

APPENDIX B

MOODLE LEARNING MANAGEMENT SYSTEM SCREENSHOTS

There is a newer Moodle version available!

Moodle 3.3.2+ (Build: 20171013) Version 2017051502.07 Stable version [Download More info...](#)

It is strongly recommended that you update your site to the latest version to obtain all recent security and bug fixes.

[Check for available updates](#)

Last check done on 17 October 2017, 2:59 AM

[Moodle 3.3+ \(Build: 20170601\)](#)
Copyright © 1999 onwards, Martin Dougiamas
and [many other contributors](#).
[GNU Public License](#)

Figure B.1 System update feature



Figure B.2 Maintenance and Upgrading

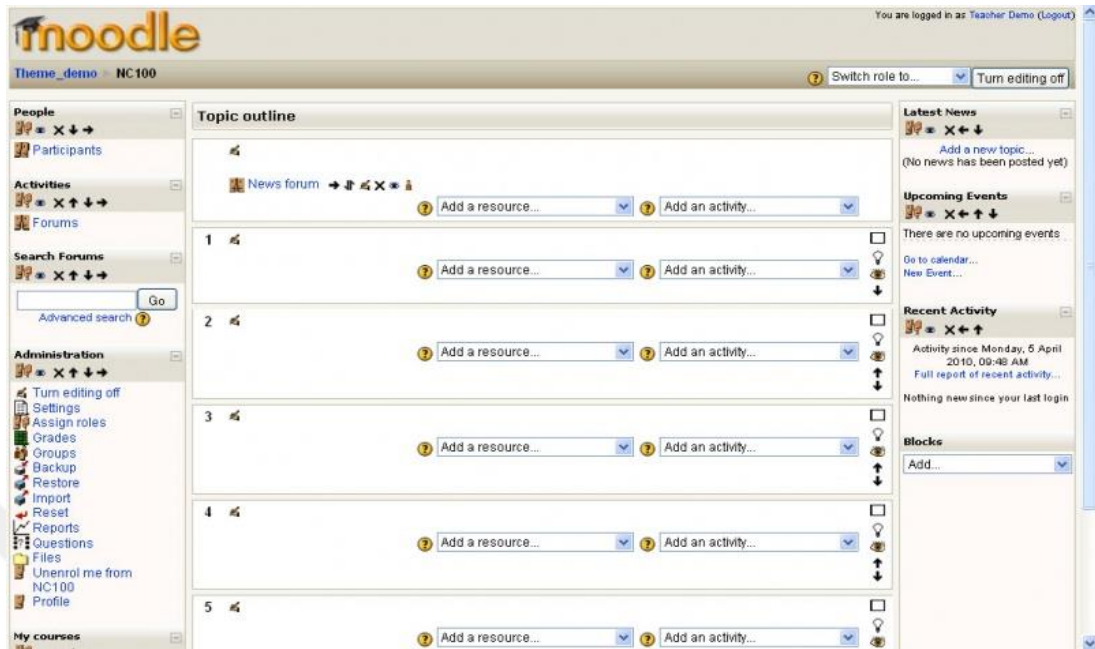


Figure B.3 Application Programming Interface

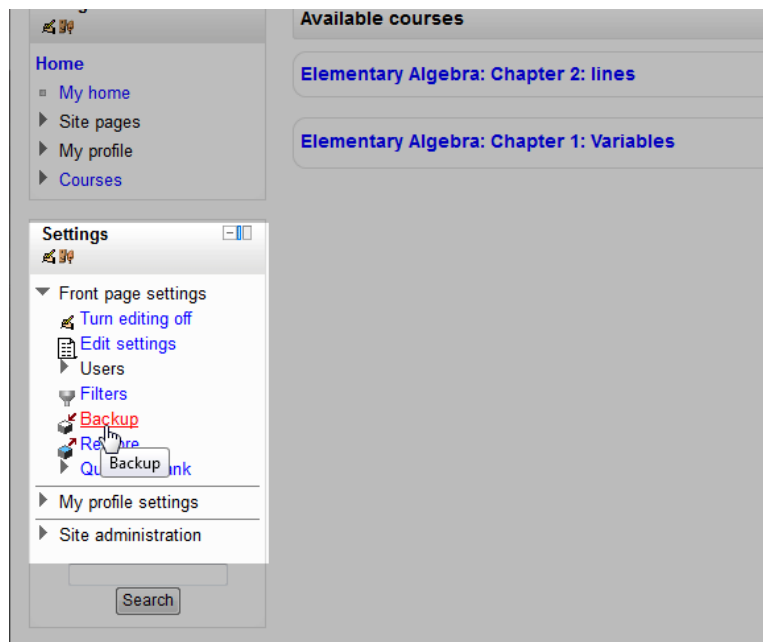


Figure B.4 Backup and Recovery Feature

Student Student

Started on Saturday, 14 April 2018, 4:51 pm
State Finished
Completed on Saturday, 14 April 2018, 4:52 pm
Time taken 35 secs
Grade 2.00 out of 2.00 (100%)

Question 1
 Correct
 Mark 2.00 out of 2.00
 Edit question

First number is ✓ second number is ✓ .

Your answer is correct.
 The correct answer is:
 First number is [one] second number is [two].
 Correct
 Marks for this submission: 2.00/2.00.

Figure B.5 Correctness

Course administration **Users**

- Edit settings
- Turn editing on
- Course completion
- Filters
- Gradebook setup
- Backup
- Restore
- Import
- Reset
- Published as LTI tools

Reports

- Competency breakdown
- Logs
- Live logs
- Activity report
- Course participation
- Activity completion
- Statistics

Figure B.6 Providing Reports About Student Progress

Dashboard / Site administration / Analytics / Analytics models Blocks editing on

New model ▾

Analytics models











Model name	Enabled	Indicators	Time splitting	Insights	Actions
Upcoming activities due  \core_user\analytics\target\upcoming_activities_due 	✓	Number of indicators: 1	Upcoming 3 days 	Choose... ▾	Actions ▾
No teaching  \core_course\analytics\target\no_teaching 	✓	Number of indicators: 2	Single range 	Choose... ▾	Actions ▾


Figure B.7 Time Analysis Feature

Select	User picture	First name / Surname	Us
<input type="checkbox"/>		Mo Langan 	z89
<input type="checkbox"/>		Dummy10 Student10 	z10

Dummy10 St

☰
🔍

tudent10



[Send a message](#)

Figure B.8 Different User Types Support

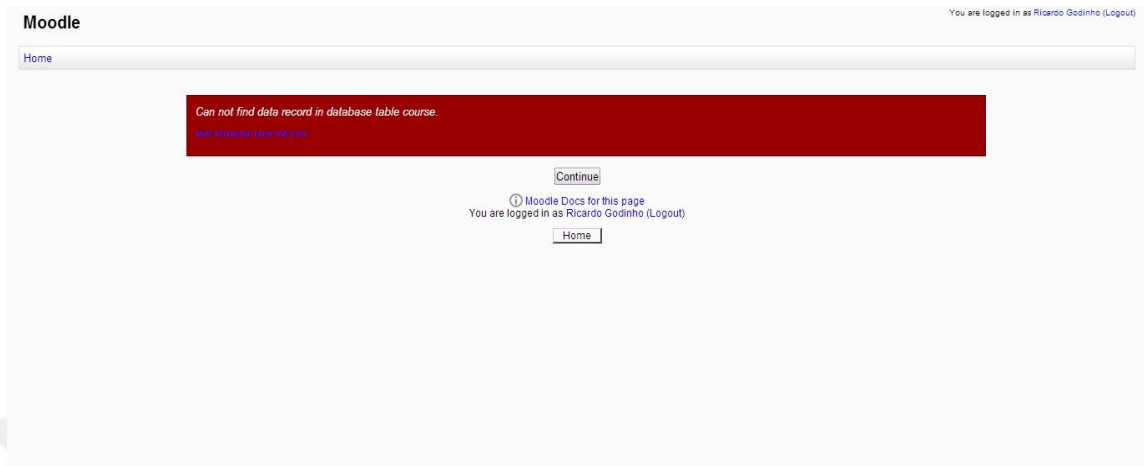


Figure B.9 Validation of Input Feature

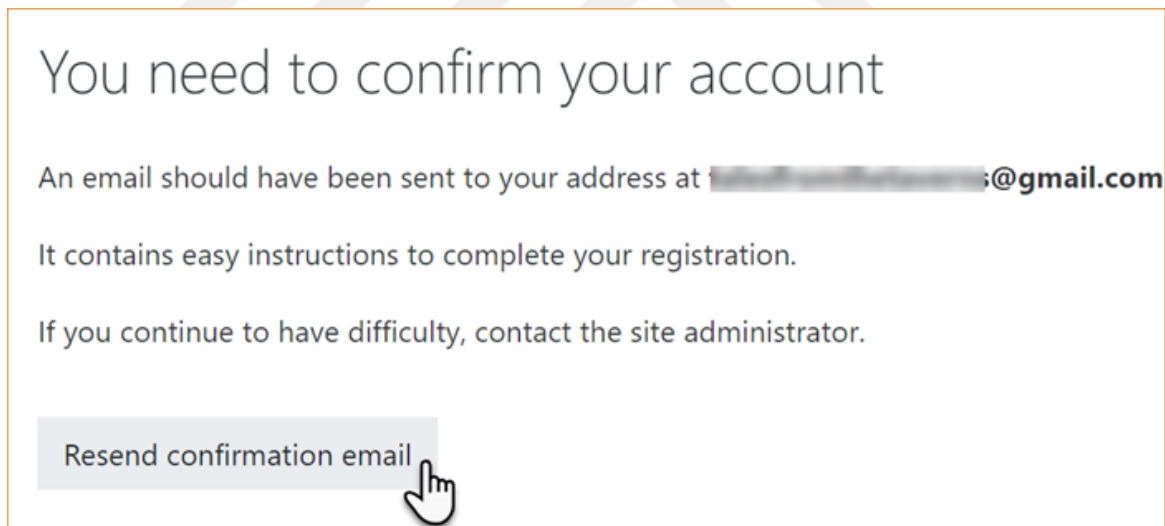


Figure B.10 Email Verification Feature



Figure B.11 LIVE Video Conferencing

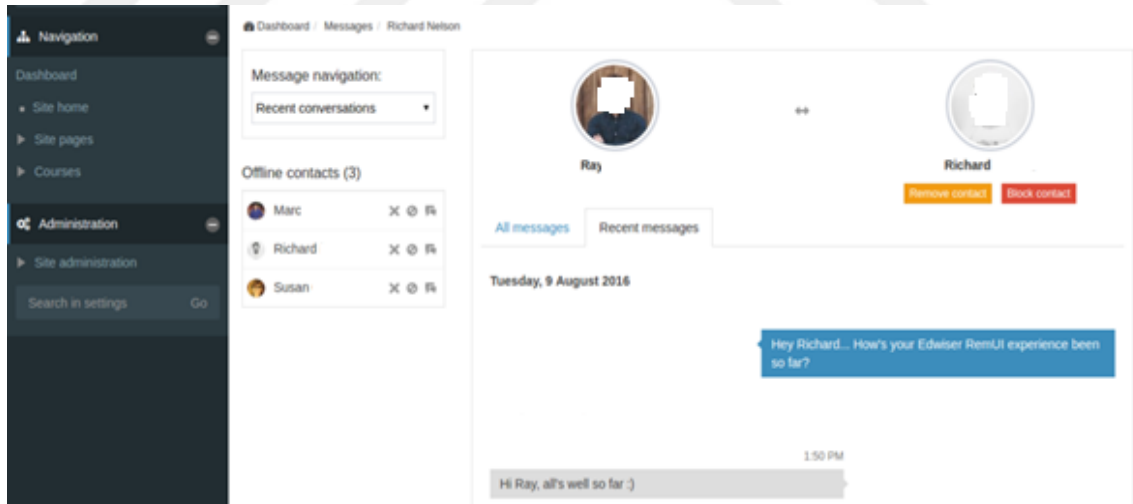




Figure B.12 Direct Communication Feature

Class discussions

Add your response to each forum post by clicking "Reply" at the bottom. Don't write the first thing that comes into your head: think a little first!

[Add a new discussion topic](#)

Discussion	Started by	Replies	Last post
Saving the revolution	 Jeffrey	1	Barbara 10:05 AM
Most important factor	 Jeffrey	0	Jeffrey 5:53 PM

Administration

- Forum administration
 - Optional subscription
 - [Unsubscribe from this forum](#)
- Course administration
- My profile settings

Figure B.13 Forum feature

Editing Page

thatthwam.com/moodle/course/modedit.php?update=3&return=0&sr=0

Most Visited

Thaththwam Up... (log in)

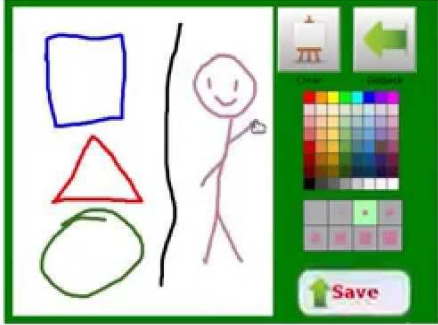
You are logged in as Admin User (Logout)

LOGO

NAVIGATION

File picker


- Embedded files
- Server files
- Recent files
- Upload a file
- URL downloader
- Private files
- Wikimedia
- PoolLL Whiteboard



Save

polymer emission Acrylic
binding on how much the
be. finished acrylic painting
visitors not attainable with

Figure B.14 Whiteboard


Share with others Get shareable link 

Link sharing on [Learn more](#)

Anyone at Carleton College with the link can view Copy link

<https://drive.google.com/a/carleton.edu/folderview?id=0B6l1jvY2f3bgcHRCa3ltMmZ>

People


Can edit 

[Advanced](#)

Figure B.15 File Sharing


Detail **Edit** Enrolments Waitlist Instructors Roles Results Engine Reports

Course (electricalsafety)Electrical Safety


Description: 

Assigned Tracks:


Unassigned Tracks:

Tracks: 


ID Number: *

Start Date:  Linking an ELIS class to a Moodle course Enable


End Date: Enable

Start Time:  Disable

End Time: Disable

Max # of Students: 

Moodle course: Auto Create Moodle course from template

Auto enrol from waitlist: 

Miscellaneous

Environment

There are required fields in this form marked *.

Use this drop down menu to link the ELIS class to a Moodle course.

Figure B.16 Linking

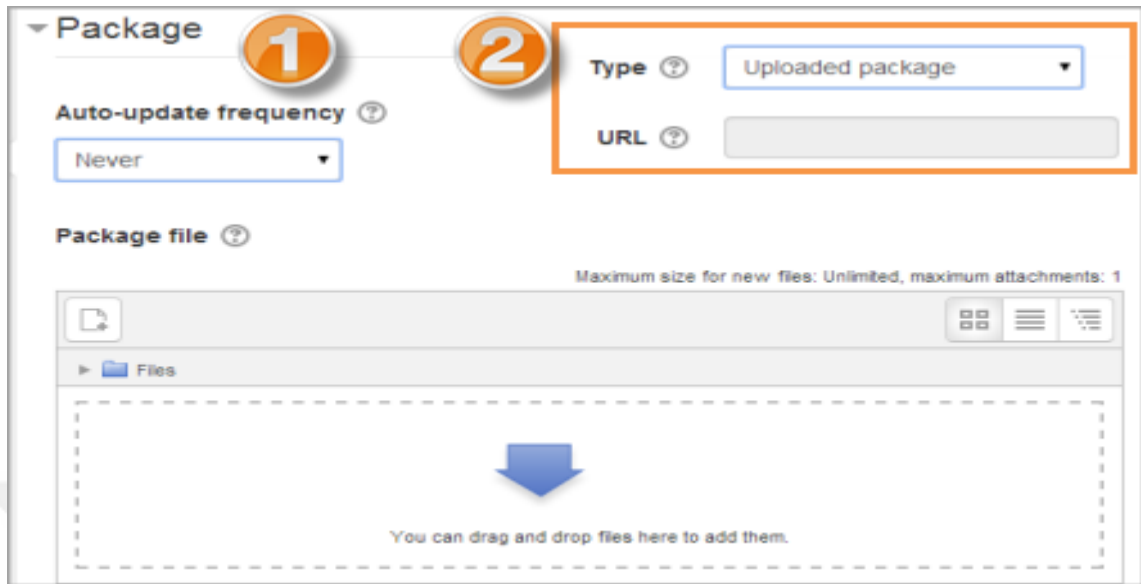


Figure B.17 Upload-Download Resource Packages

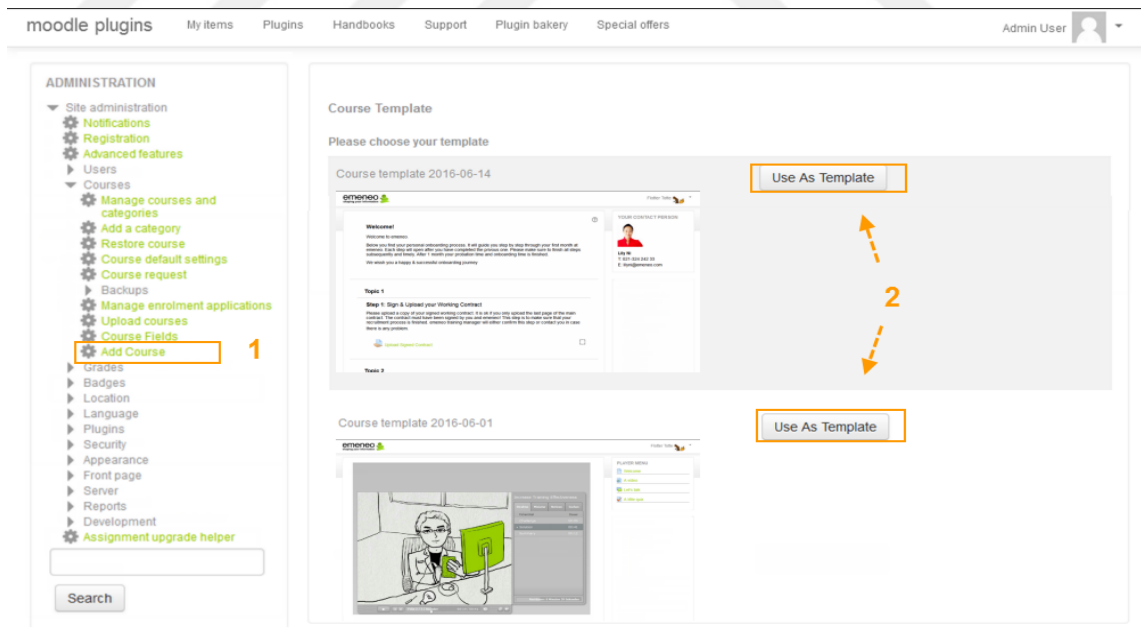


Figure B.18 Course Template

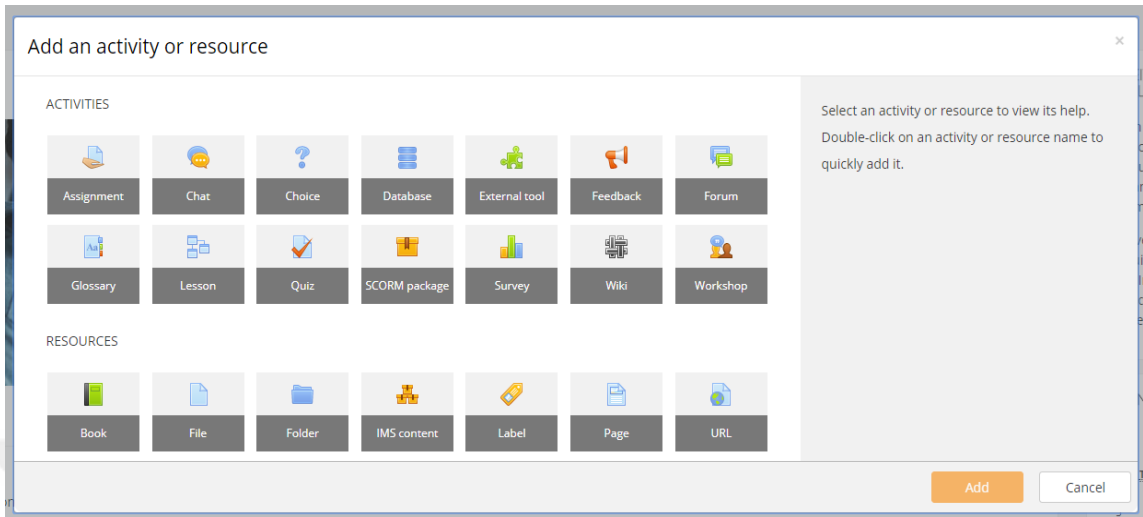


Figure B.19 Interactive Activities During the Learning

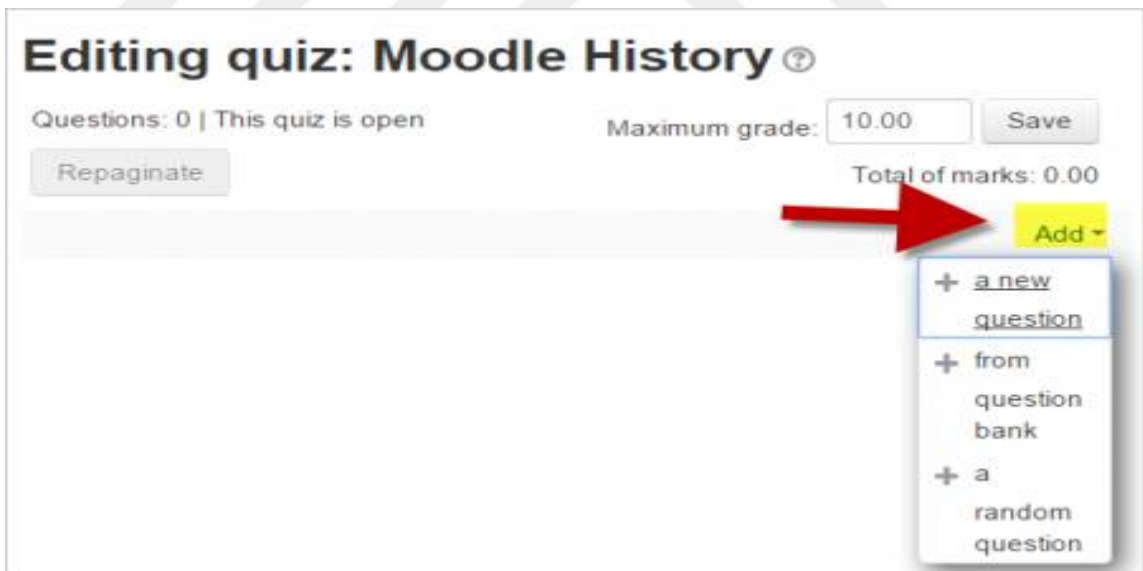


Figure B.20 Online Quiz Editor

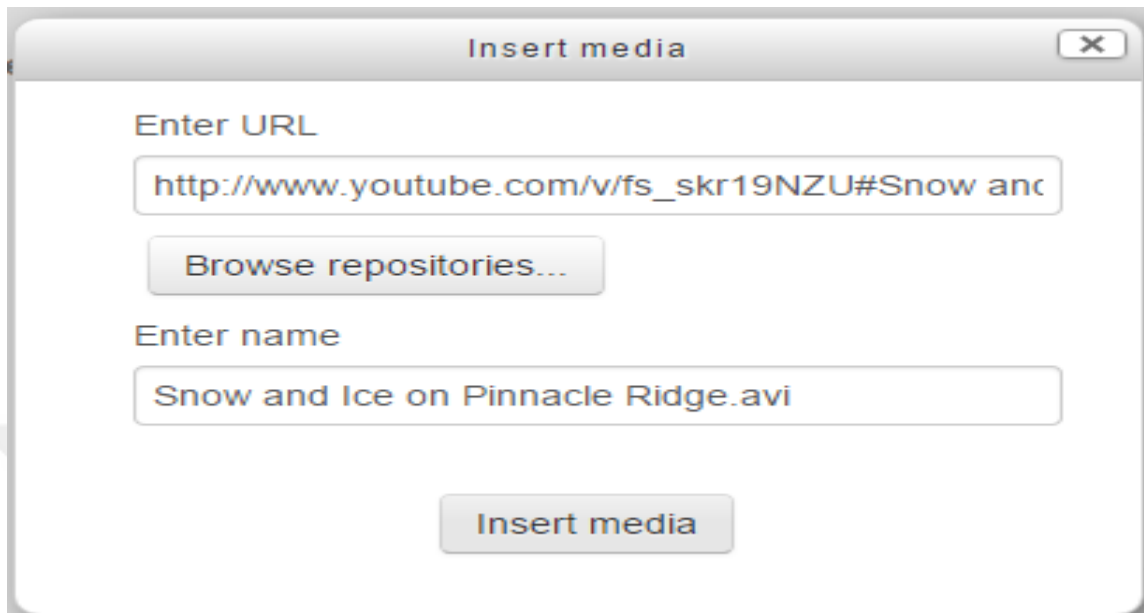


Figure B 21 YouTube Integration

assessment with Moodle You are logged in as Sample Student1 (Logout)

ant > Gradebook, Grading & Rubrics > Rubric for Self-Assessment > View assignment grades and feedback

Separate groups: Group 1

First name : AllABCDEFGHIJKLMNOPQRSTUVWXYZ
Surname : AllABCDEFGHIJKLMNOPQRSTUVWXYZ

First name / Surname	Email address	Grade	Comment	Last modified (Submission)	Last modified (Grade)	Status	Fir
Sample Student1	sstudent1@mail.com	-				Grade	

Optional settings

Show: All

Submissions shown per page: 10

Save preferences

This screenshot shows Sample Student1 logged in with access to the Assignment page and Grade. The student only has access to her rubric due to separate and hidden groups used on the assignment settings page and removing the permission of the non-editing teacher to access all groups.

Figure B 22 Self-Evaluation

Using wikis in teaching and learning

Select	Edit	User picture	First name / Surname	Status	Grade	Last modified (submission)	File submissions	Last modified (grade)	Feedback comments	Feedback files	Final grade
<input type="checkbox"/>	<input type="checkbox"/>		Sam Student	Submitted for grading	<input type="checkbox"/> / 100.00	Thursday, 21 June 2012, 8:33 AM	Export to portfolio	-	<input type="text"/>		-
<input type="checkbox"/>	<input type="checkbox"/>		Sally Student	Submitted for grading	<input type="checkbox"/> / 100.00	Thursday, 21 June 2012, 8:34 AM	Export to portfolio	-	<input type="text"/>		-
<input type="checkbox"/>	<input type="checkbox"/>		Student 3	Draft (not submitted)	<input type="checkbox"/> / 100.00	Thursday, 21 June 2012, 8:34 AM	Export to portfolio	-	<input type="text"/>		-
<input type="checkbox"/>	<input type="checkbox"/>		Student 4	Submitted for grading	<input type="checkbox"/> / 100.00	Thursday, 21 June 2012, 8:35 AM	Export to portfolio	-	<input type="text"/>		-
<input type="checkbox"/>	<input type="checkbox"/>		Student 5	No submission	<input type="checkbox"/> / 100.00	-		-	<input type="text"/>		-
<input type="checkbox"/>	<input type="checkbox"/>		Student 6	Submitted for grading	<input type="checkbox"/> / 100.00	Thursday, 21 June 2012, 8:36 AM	Export to portfolio	-	<input type="text"/>		-
<input type="checkbox"/>	<input type="checkbox"/>		Student 7	Submitted for grading	<input type="checkbox"/> / 100.00	Thursday, 21 June 2012, 8:37 AM	Export to portfolio	-	<input type="text"/>		-

[Save all quick grading changes](#)

With selected... Lock submissions Go

Options

Assignments per page:

Filter:

Quick grading:

Figure B 23 Online Grading Feature

The screenshot shows the Moodle plugins directory interface. At the top, there's a navigation bar with links for DOCUMENTATION, DOWNLOADS, DEMO, TRACKER, DEVELOPMENT, TRANSLATION, and MOODLENET. Below this is the Moodle logo and a search bar. The main content area displays several plugin cards, each with a title, description, and a thumbnail image. The cards include:

- Essential**: A clean and customizable theme.
- Questionnaire**: Custom Survey Creation.
- Certificate**: Dynamic generation of certificates based on predefined conditions.
- HotPot**: HotPot module for Moodle 2.x.
- Configurable Reports**: A Moodle custom reports builder.
- Progress Bar**: A time management tool for students.

On the right side, there's a sidebar with statistics (1250 plugins, 693 devs, 434.1K recent downloads) and a 'Moodle Certified Service Provider' badge. Below that is a 'NAVIGATION' section with links for Home, Search, Communities, Plugins, Plugin reviews, Statistics, Reports, and Plugin types. At the bottom, there's a 'PLUGINS TRAFFIC' section with links for Try out the new Moodle plugins directory interface, Plugins adoption, and Moodle 3.7 core url.

Figure B 24 Transcripts and certificates

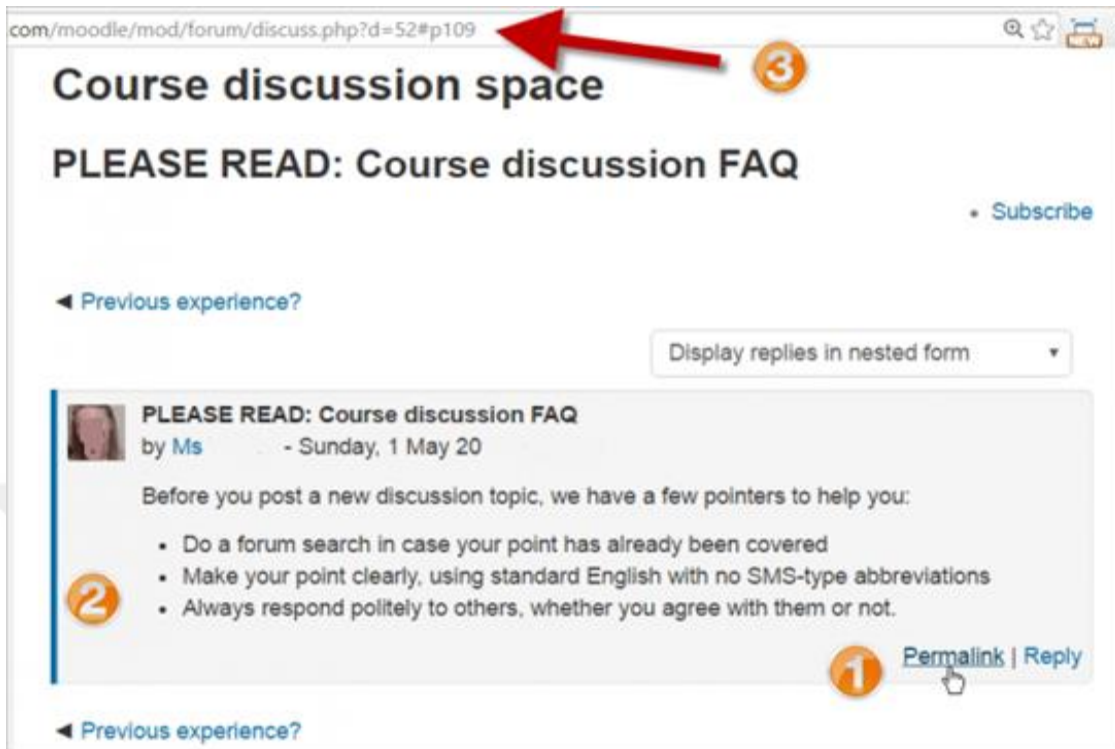


Figure B 25 Answers to Frequently Asked Questions

Activity module: Midterm Reflection | Look back: 2 days | Show only: Student | Show actions: All actions | Go

Groups: All participants | Assignment Views | Assignment Posts

4 Student

Choose which activity, how far to look back, what role for participants (e.g., students or TAs), and which actions (e.g., view or add).

First name / Last name	All actions
Acstu1 Test	No
Acstu2 Test	Yes (2)
Acstu3 Test	No
Acstu4 Test	No

Figure B 26 Participant Administration for Online Courses

APPEBDIX C

OPENEDX LEARNING MANAGEMENT SYSTEM SCREENSHOTS

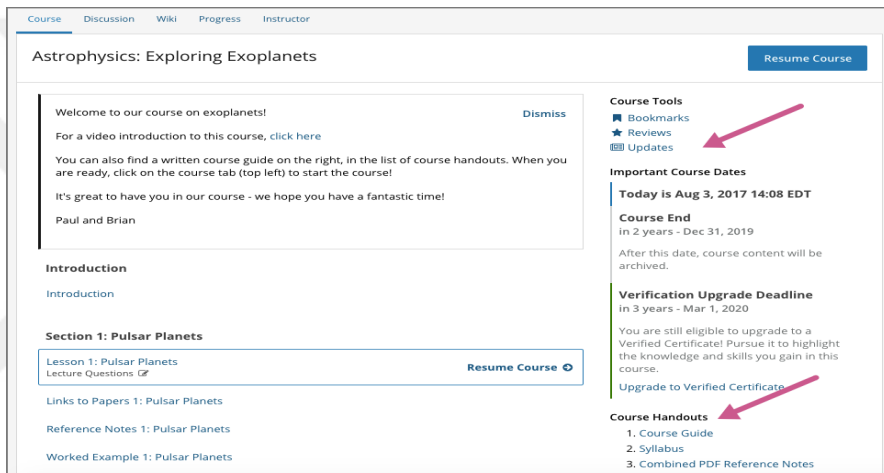


Figure C 1 System Update Feature

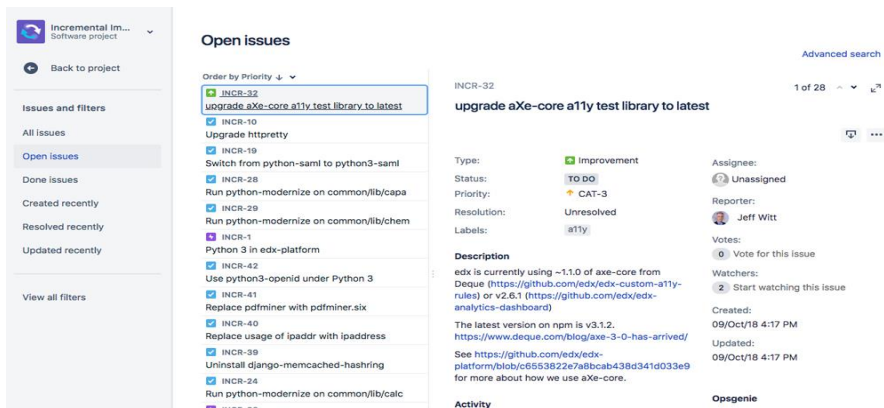


Figure C 2 Maintenance and Upgrading

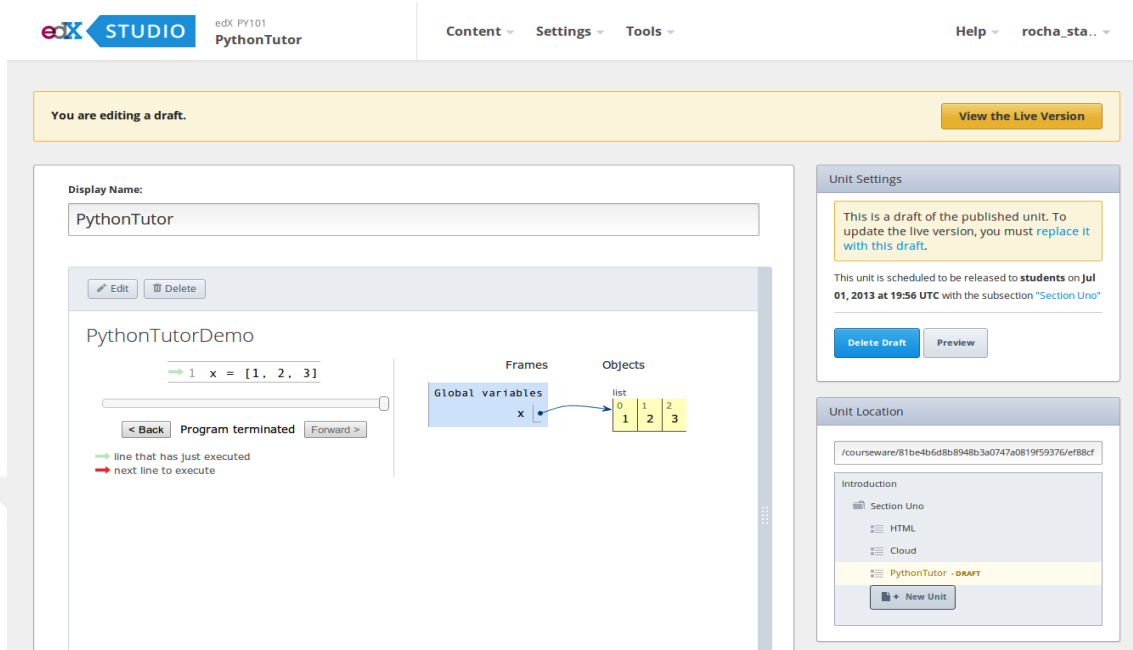


Figure C 3 Application Programming Interface

```

FORUM_MONGO_USER: "cs_comments_service"
FORUM_MONGO_PASSWORD: 'J'
RABBIT_ADMIN_PASSWORD: '

# Secret keys for Django Applications
ANALYTICS_API_SECRET_KEY: 'U
CREDENTIALS_SECRET_KEY: 'U2J
DISCOVERY_SECRET_KEY: 'taEch
ECOMMERCE_SECRET_KEY: 'F1K0V
EDX_NOTES_API_SECRET_KEY: 'E
EDXAPP_EDXAPP_SECRET_KEY: 'j
EDXAPP_PROFILE_IMAGE_SECRET_
INSIGHTS_SECRET_KEY: 'Kf4dox
NOTIFIER_LMS_SECRET_KEY: 'ot

MONGO_USERS:
- user: "{{ FORUM_MONGO_USER }}"
  password: "{{ FORUM_MONGO_PASSWORD }}"
  database: cs_comments_service
  roles: readWrite
- user: "{{ EDXAPP_MONGO_USER }}"
  password: "{{ EDXAPP_MONGO_PASSWORD }}"
  database: edxapp
  roles: readWrite

RABBIT_USERS:
- name: 'admin'
  password: "{{ RABBIT_ADMIN_PASSWORD }}"
- name: 'edx'
  password: "{{ XQUEUE_RABBITMQ_PASS }}"
- name: 'celery'
  password: "{{ EDXAPP_CELERY_PASSWORD }}"

```

Figure C 4 Backup and Recovery Feature

Multiple Choice with Hints and Feedback
1 point possible (graded)

Which of the following is a vegetable?

apple

pumpkin **✘**

potato

tomato

Answer
Incorrect: A pumpkin is the fertilized ovary of a squash plant and contains seeds, so it is a fruit.

? **Hint (1 of 2):** Remember that a fruit is the part of the plant that has developed from the ovary of a plant, and contains seeds. [Next Hint](#)

Submit You have used 1 of 3 attempts [? Hint](#) [Save](#) [Reset](#) [Show Answer](#)

Figure C 5 Correctness

eduNEXT management console jalondonot

recycled sites
Status: ACTIVE
Subscription: LITE
[UPGRADE PLAN](#)

Monitoring
Microsites settings
LMS platform
STUDIO platform
Help

Active users
<https://afibeta.edu.nxt.io>

This dashboard shows the number of active users in your microsite.
A visitor is counted as an active user only when he visits the courseware or the discussions inside your course.

This month	Last 7 days	Today
0	0	0

Last 7 days

2019-03-23
Active users: 0

Saturday Sunday Monday Tuesday Wednesday Thursday Friday

© 2019 powered by **eduNEXT**

Figure C 6 Time Analysis Feature

Course Organization Display String

"My New Organization"

Enter the course organization that you want to appear in the course. This setting overrides the organization that you entered when you created the course. To use the organization that you entered when you created the course, enter null.

You've made some changes
Your changes will not take effect until you save your progress. Take care with key and value formatting, as validation is not implemented.

Save Changes

Figure C 7 Validation of Input Feature

Check Your Email

You entered **lpm0073@gmail.com**. If this email address is associated with your edX account, we will send a message with password reset instructions to this email address. If you do not receive a password reset message, verify that you entered the correct email address, or check your spam folder. If you need further assistance, [contact technical support](#).

First time here? [Create an Account](#).

Sign In

Email

lpm0073@gmail.com

The email address you used to register with edX

Password

.....

[Forgot password?](#)

Remember me

Sign in

Figure C 8 Email Verification Feature

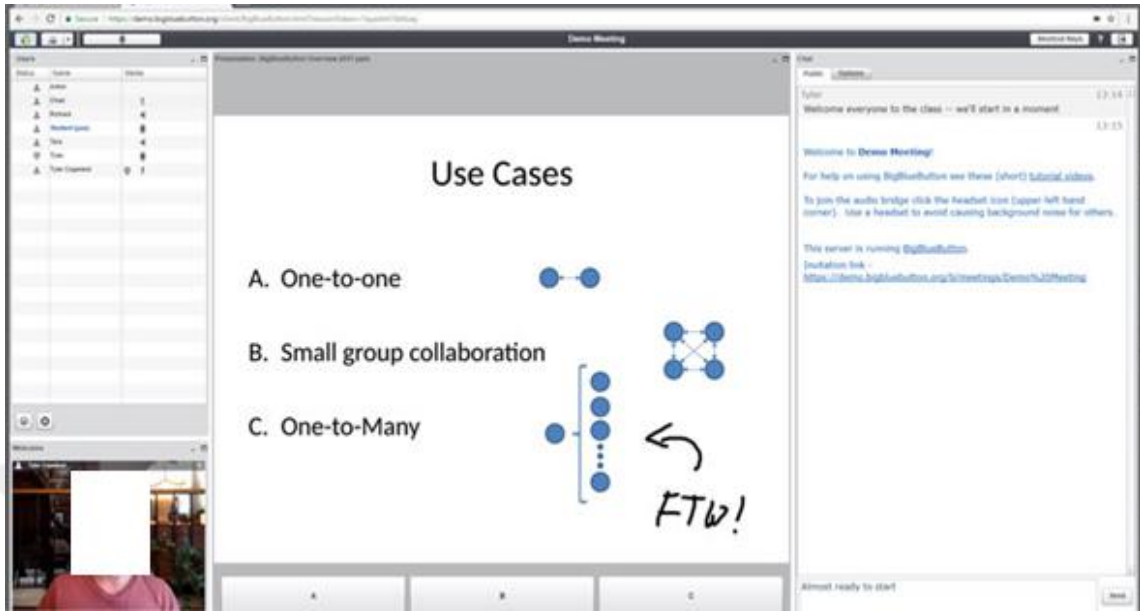


Figure C 9 LIVE Video Conferencing

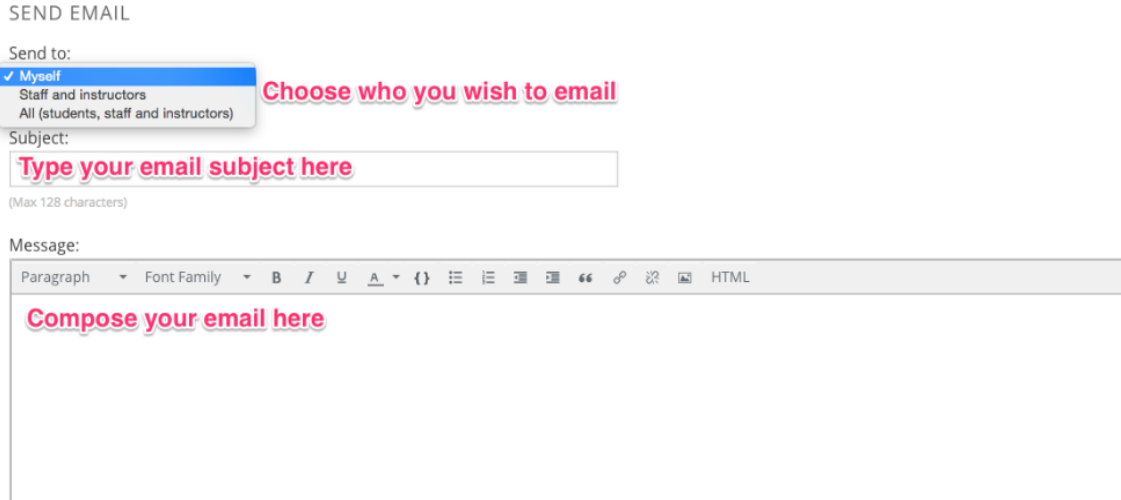


Figure C 10 Direct Communication Feature

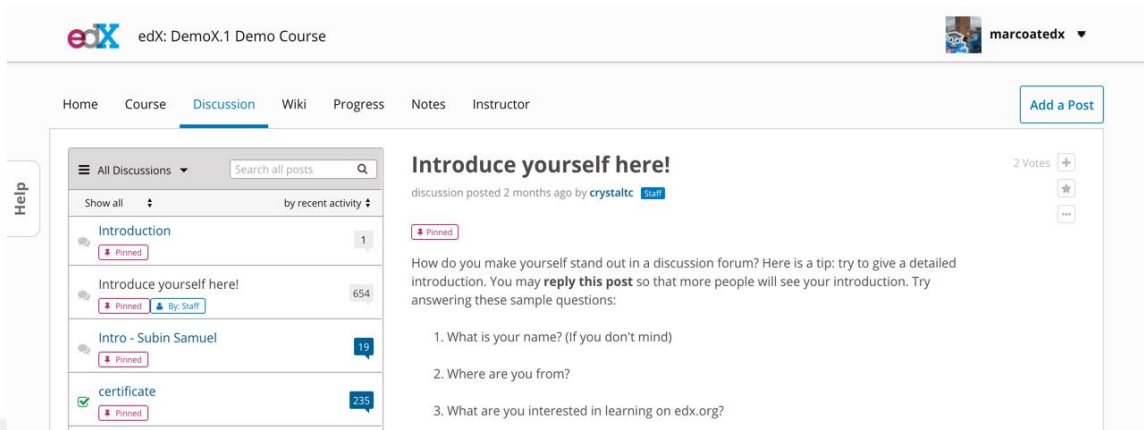


Figure C 11 Forum Feature

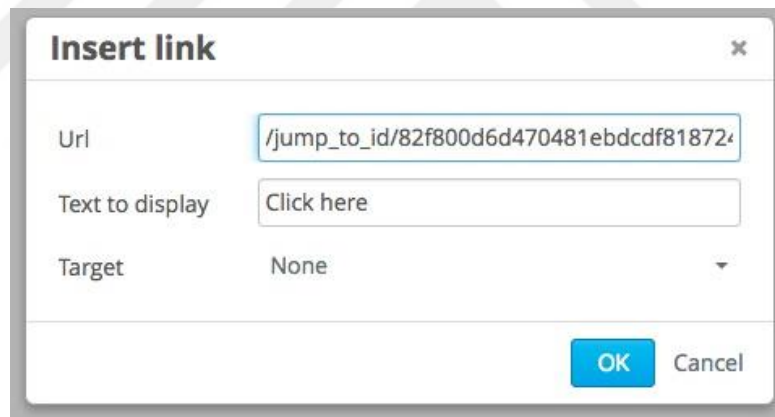


Figure C 12 Linking

Course Administration admin

Courses

[Click Here](#)
Add New Course

Display 10 courses Search...


Course	Course Type	Last Edited
E-Commerce testing course course-v1:NR+NR101+2016_Spring	Professional	August 22, 2016, 11:16 AM
Testing course course-v1:edX+Test101+course	Professional	August 22, 2016, 7:27 AM

Displaying 1 to 2 of 2 courses < Previous 1 Next >

Your Platform Name Here Course Administration Tool

Figure C 13 Create/Delete Courses


CURRENT COURSES



User Innovation: A path to entrepreneurship

MITx - uINOV8x
Starts - May 15, 2015

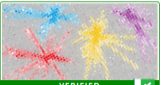
Challenge Yourself Take this course as an ID-verified student.



Data Analysis: Take it to the MAX()

DelftX - EX101x
Started - Mar 31, 2015

Challenge Yourself Take this course as an ID-verified student. **View Course**



Introduction to Computational Thinking and Data Science

MITx - 6.00.2x
Ended - May 09, 2014

Your final grade: **77%** Download Your ID Verified Certificate (PDF)

in Add to profile

Figure C 14 Course Template

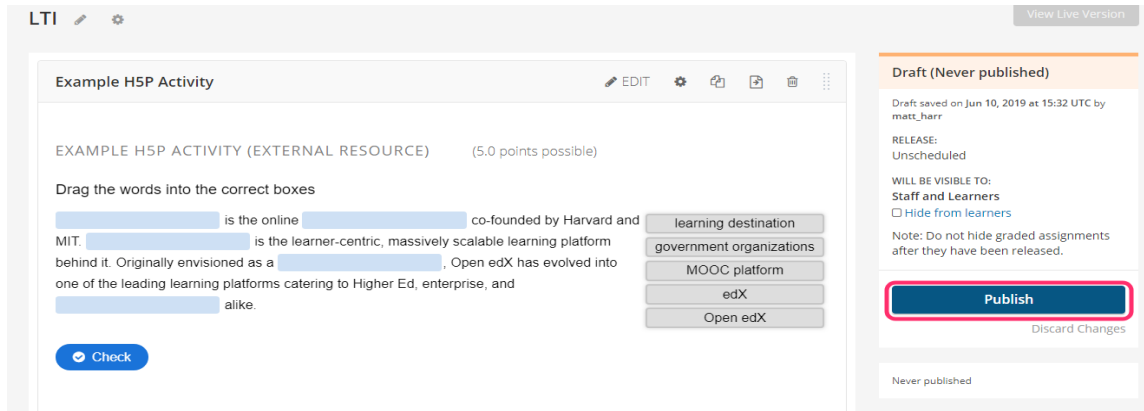


Figure C 15 Interactive Activities During the Learning

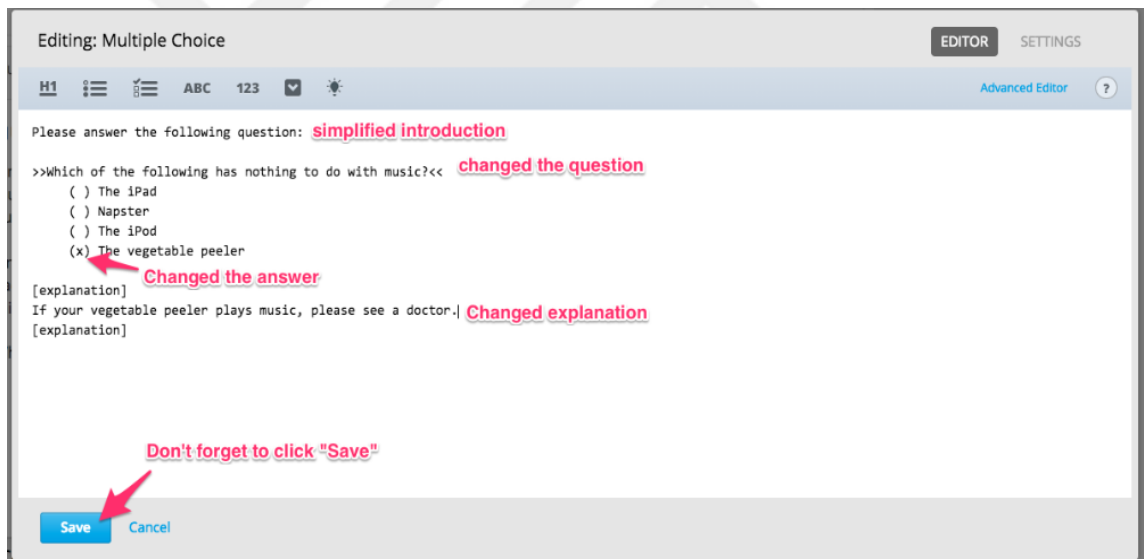


Figure C 16 Online Quiz Editor

VIDEO

TCP "stream of bytes" service

Table of contents with clickable links

- Opening
- Peer layers communicate
- The TCP service model
- Stream of bytes**
- The TCP segment format

3:51 / 16:58 | SPEED 1.0x | HD | CC

Figure C 17 YouTube Integration

Status

You have completed this assignment. Review your grade and your assessment details.

- Your Response** ✓ COMPLETE

The question for this section

Describe your favorite meal, and write a persuasive argument to convince someone to try that meal. Support your position with facts and examples from your experience.

Your response

Mmmm sushi
- Learn to Assess Responses** ✓ COMPLETE
- Assess Peers** ✓ 3 COMPLETED
- Assess Your Response** ✓ COMPLETE

Figure C 18 Self-Evaluation

edX

<< Back to Dashboard

Gradebook

course-v1:MITx+6.002x+MITx_2012_Alumni

Score View: Percent Absolute

Assignment Types: All

Student Groups: Track-All Cohort-All

Generate Grade Report

Search:

Previous Page Next Page

Username	HW 01	Lab 01	HW 02	Lab 02	HW 03	Lab 03	HW 04	Lab 04
e0d	0%	0%	0%	0%	0%	0%	0%	0%
user-1	0%	0%	0%	0%	0%	0%	0%	0%

Figure C 19 Online Grading Feature

1:05 / 4:01

Speed 1.0x

HD

Transcripts

Download video file

Download SubRip (.srt) file

Download Text (.txt) file

Figure C 20 Transcripts and certificates

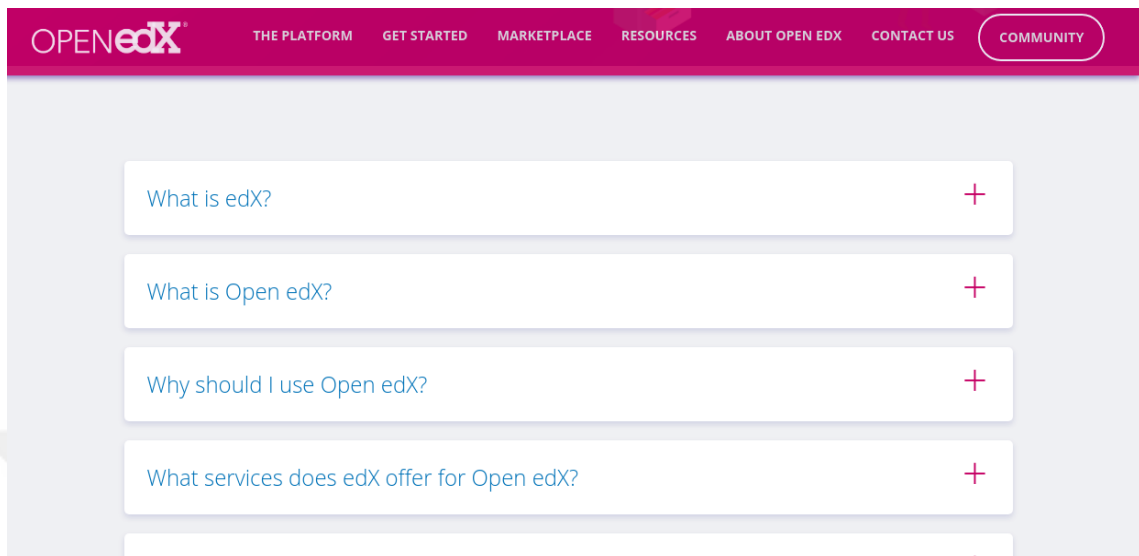


Figure C 21 Answers to Frequently Asked Questions

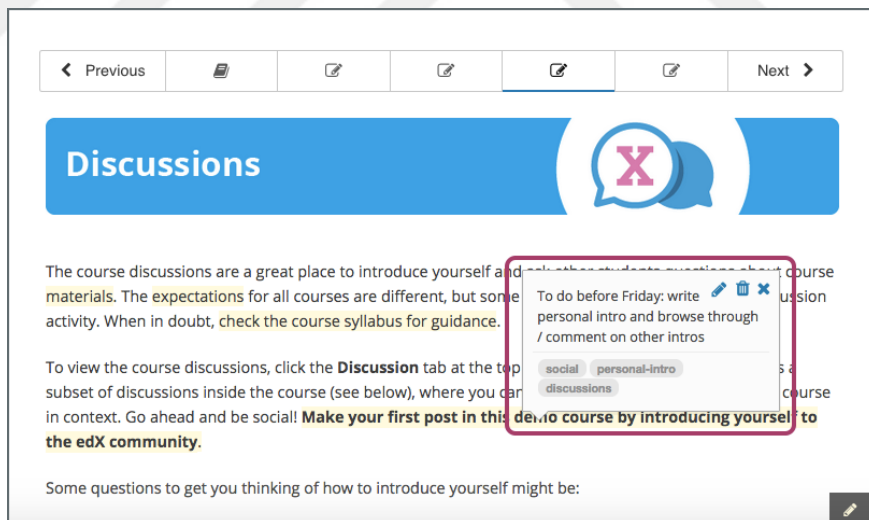


Figure C 22 Participant Administration for Online Courses

APPENDIX D

SAKAI LEARNING MANAGEMENT SYSTEM SCREENSHOTS

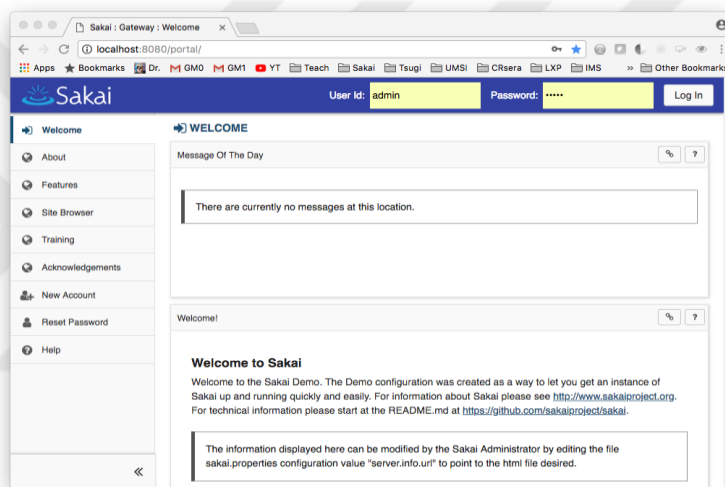


Figure D 1 Application Programming Interface

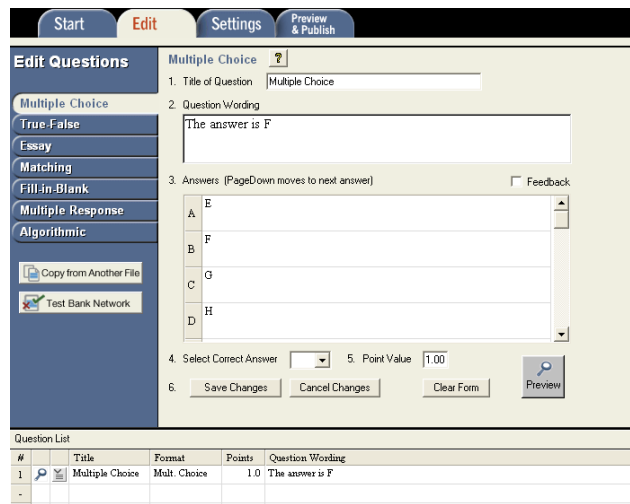


Figure D 2 Correctness

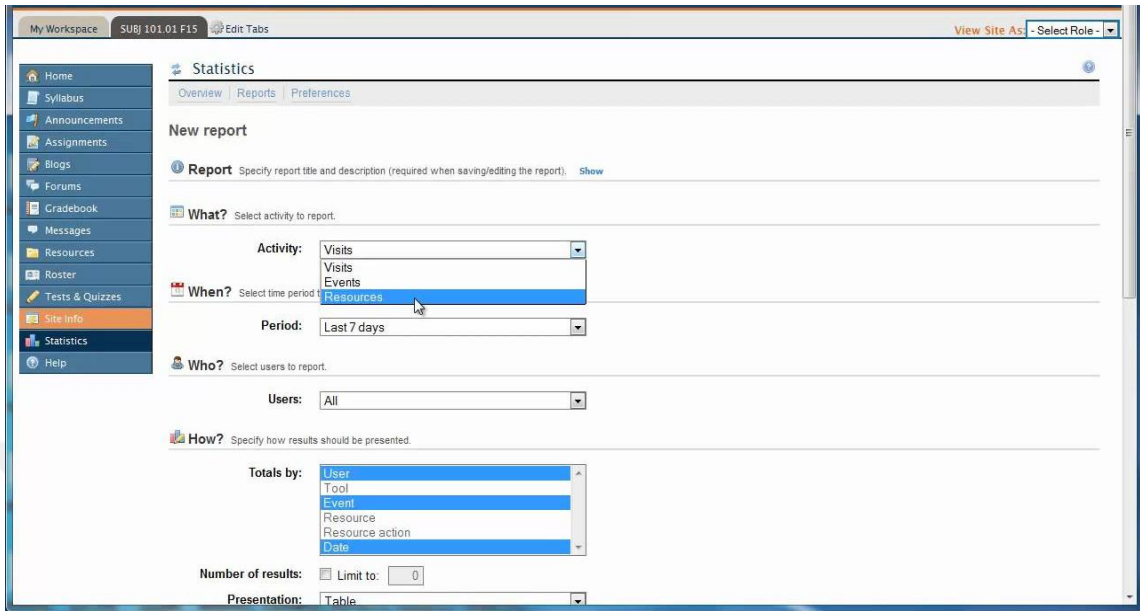


Figure D 3 Providing Reports about Student Progress

Working Copies: not released to students **Published Copies:** released to students

Action	Title	Last Modified
<ul style="list-style-type: none"> -- Select Action -- -- Select Action -- Edit Preview Print <li style="background-color: #0070C0; color: white;">Settings <li style="border: 2px solid red;">Publish Duplicate Export Remove 	Allow Retake	Instructor Thirty 07/30/2013 12:22:54 PM
	Create New Quiz	Instructor Thirty 07/30/2013 11:48:23 AM
	Even Group Assignment	Instructor Thirty 07/30/2013 11:54:54 AM

Figure D 4 Time Analysis Feature

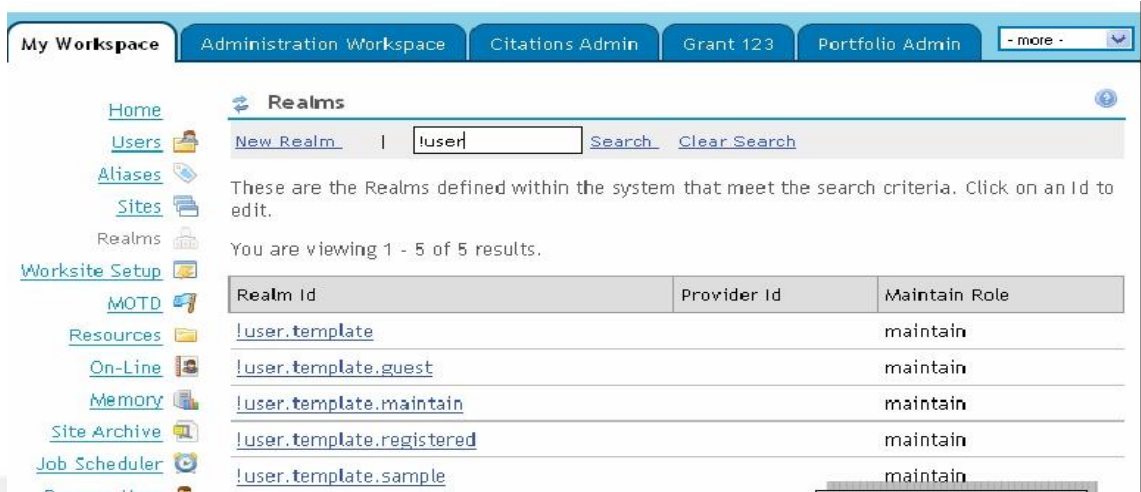


Figure D 5 Different user types support

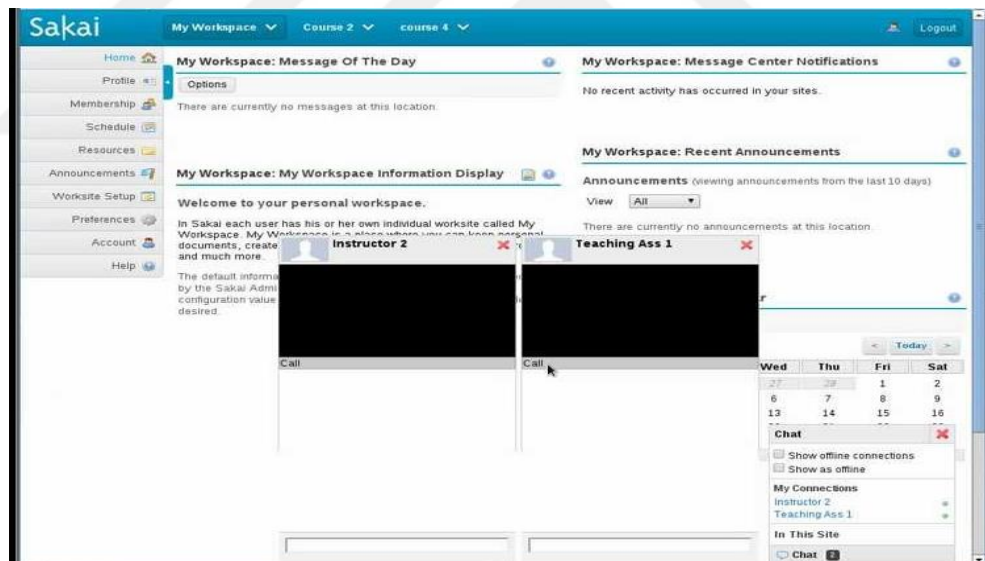


Figure D 6 LIVE Video Conferencing

SITE INFO

Add participant(s) to ALSS_987M_3979

An email can be automatically sent to the added users notifying them of the site's availability.

Send Now - send an email now to users notifying them that the site is available

Don't Send - do not send an email notifying new participants about the site's availability

[Continue](#) [Back](#) [Cancel](#)

Figure D 7 Direct Communication Feature

5
10
Builder
Builder

Attachments
No attachments have been made
[Add attachments](#)

Forum Posting
Lock Forum (Disable forum postings) Yes No
Moderate Topics in Forum Yes No

Availability
 Show - display immediately with no time restriction
 Specify Dates - begin display on (optionally) specified Beginning Date/Time; hide display after (

Mark Threads Read

Figure D 8 Forum Feature

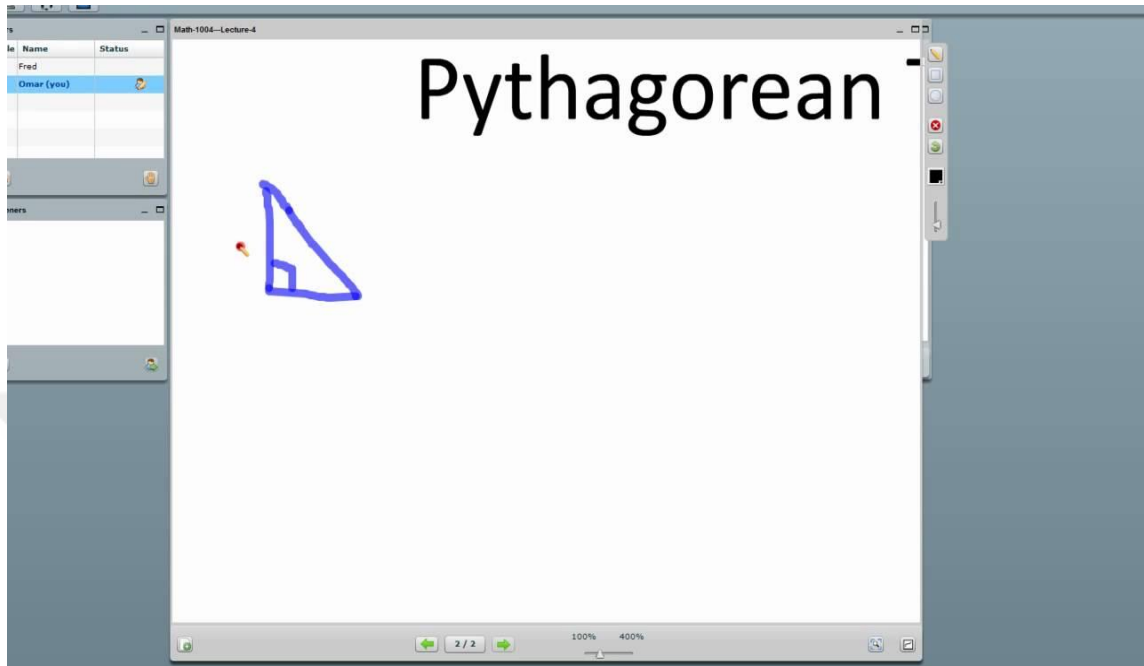


Figure D 9 Whiteboard

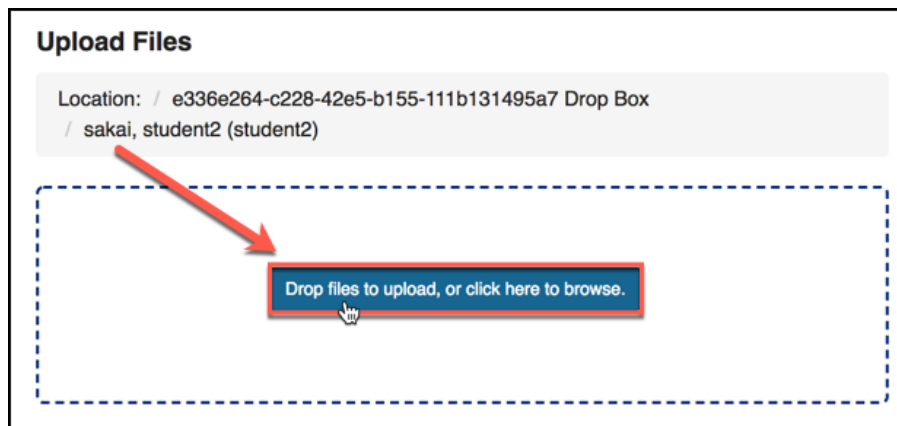


Figure D 10 File Sharing

Adding text to: Syllabus

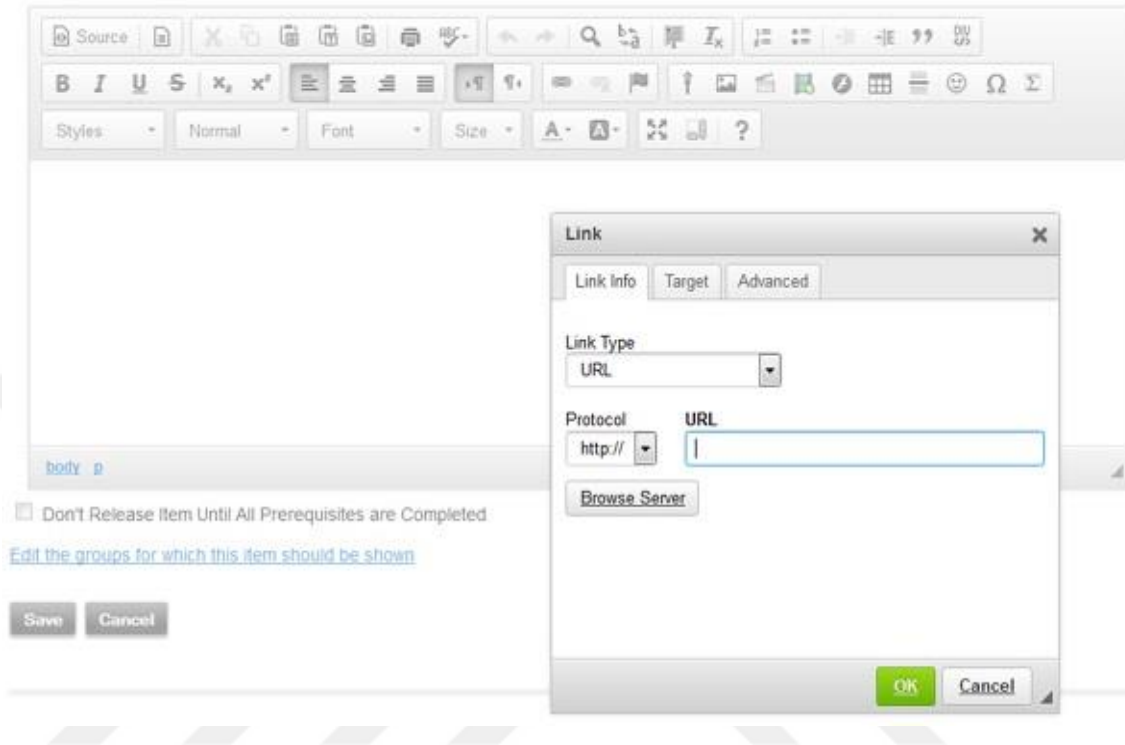


Figure D 11 linking

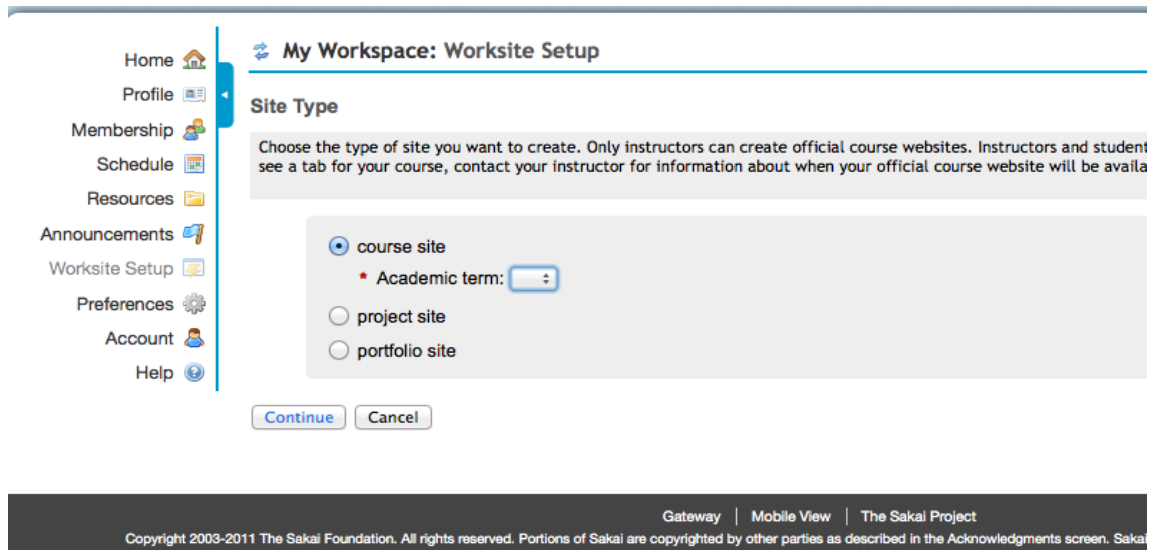


Figure D 12 Create/Delete Courses

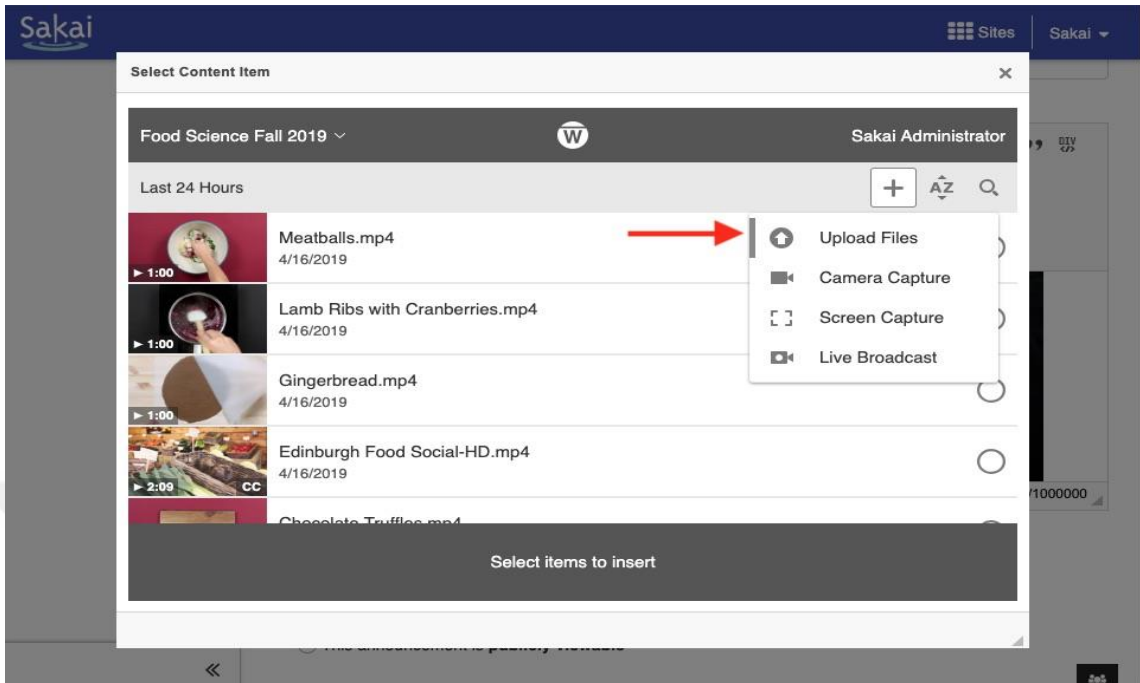


Figure D 13 Upload-Download Resource Packages

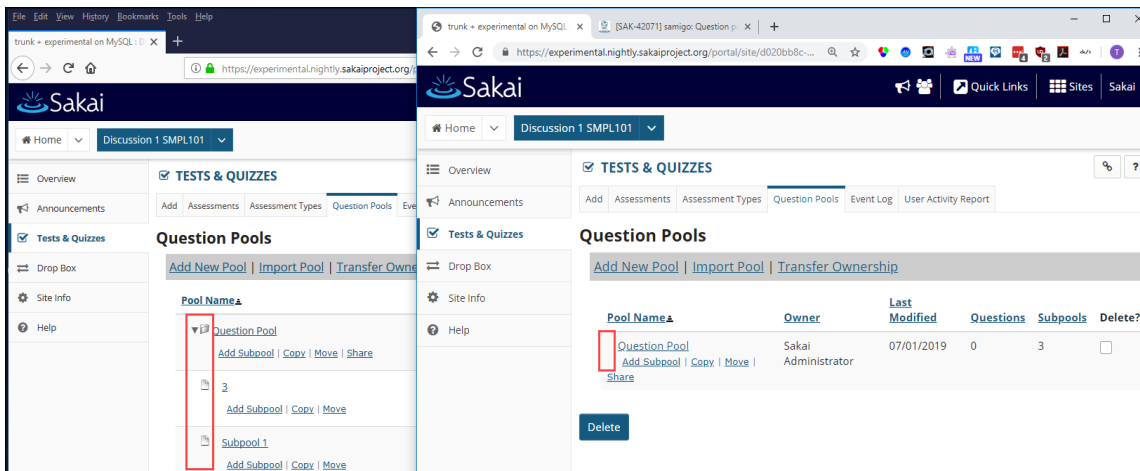


Figure D 14 Self-Evaluation

Figure D 15 Online Quiz Editor

Students	Course Grade	Homework 1 Total: 100 Due: 11/11/2015	Homework 2 Total: 100 Due: 11/18/2015	Homework 3 Total: 100 Due: 11/25/2015	Homework 4 Total: 100 Due: 04/14/2016	Homework 5 Total: 10 Due: -	Homework	midterm
Tester_Julio (ht116)	A- (91.63%)	100	80	100	17	10	74.88%	
Tester_Taavi S (ht288)	D (64.61%)	90	80	30		10	67.74%	
Tester_Tabitha S (ht283)	B- (48.09%)	65	70	67		10	68.59%	
Tester_Tabitha S (ht282)	F (56.77%)	98	80	76		10	85.16%	
Tester_Tiaco S (ht1101)	F (57.42%)	87	90	80		10	86.13%	
Tester_Tacy S (ht286)	F (42.15%)	100	80	6		10	63.23%	
Tester_Tabitha S (ht288)	F (22.87%)	0	80	6		10	30.97%	
Tester_Takhi S (ht287)	F (43.33%)	7	80	8			31.67%	
Tester_Takhi S (ht284)	F (47.39%)	7	79	6			30.67%	
Tester_Takhi S (ht289)	F (36%)	76	80	6			54%	
Tester_Tara S (ht322)	F (35.5%)	65	70	6			47%	
Tester_Tb S (ht163)	F (36.22%)	103	60	0			54.33%	
Tester_Ten Feb (ht571)	F (20.89%)	7	87	0			31.33%	
Tester_Terfel S (ht227)	F (19.33%)	7	80	0			29%	
Tester_Terfel S (ht227)	F (19.33%)	7	80	0			29%	

Figure D 16 Online Grading Feature

- Home
- Users
- Aliases
- Sites
- Realms
- Worksite Setup
- MOTD
- Resources
- On-Line
- Memory
- Site Archive
- Help

Resources

Site Resources | Upload-Download Multiple Resources

Location: Administration Workspace Resources

Remove Checked | Move Checked | Copy Checked

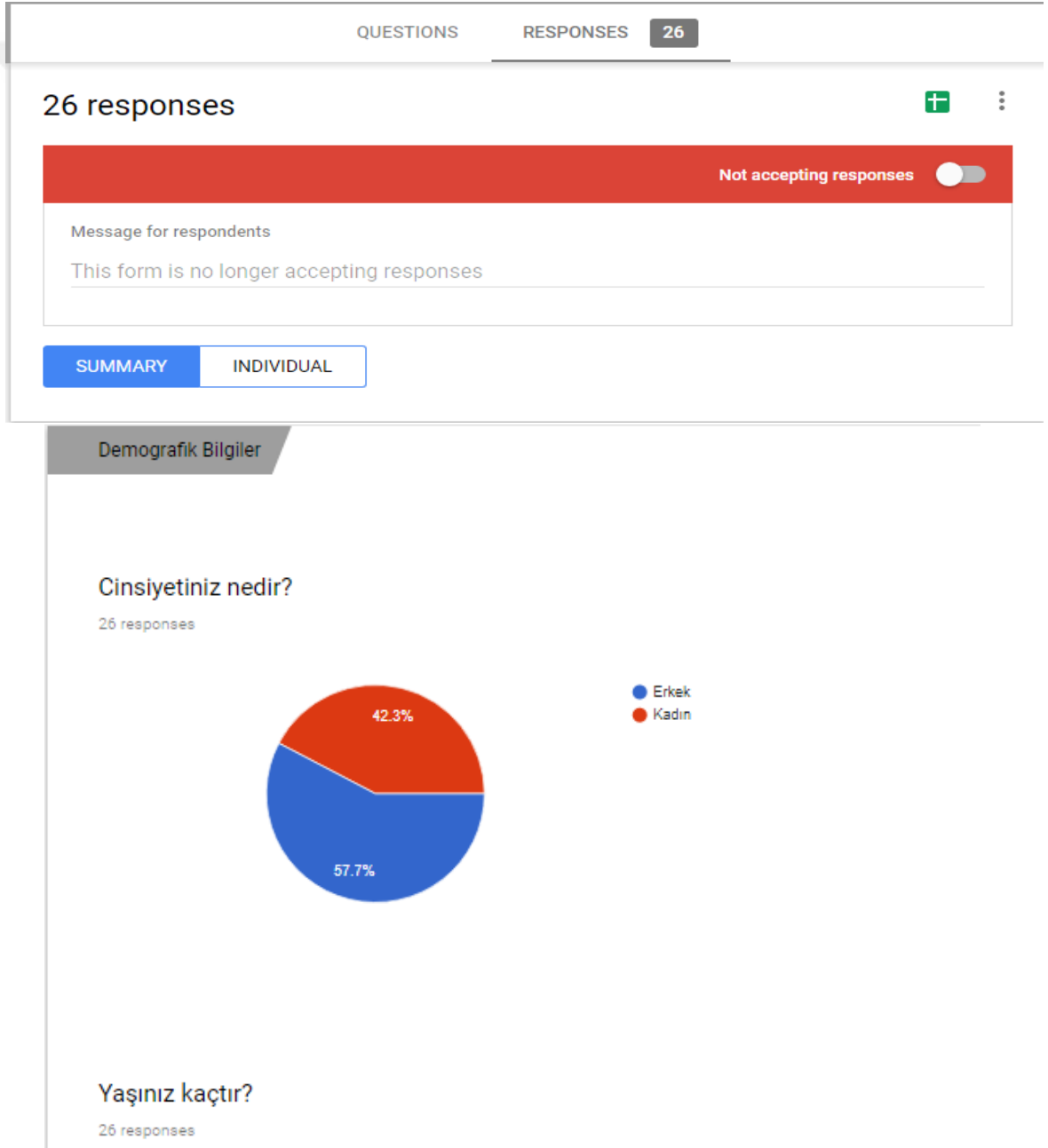
<input type="checkbox"/>	Title	Actions	Created By	Modified	Size
<input type="checkbox"/>	Administration Workspace Resources	Add Revise properties			
<input type="checkbox"/>	attachment	Add Revise properties	Sakai Administrator	04/01/02	
<input type="checkbox"/>	group	Add Revise properties	Sakai Administrator	04/01/02	
<input type="checkbox"/>	group-user	Add Revise properties	Sakai Administrator	04/01/02	
<input type="checkbox"/>	public	Add Revise properties	Sakai Administrator	04/01/02	
<input type="checkbox"/>	user	Add Revise properties	Sakai Administrator	04/01/02	

[Show other sites](#)

Figure D 17 Participant Administration for Online Courses

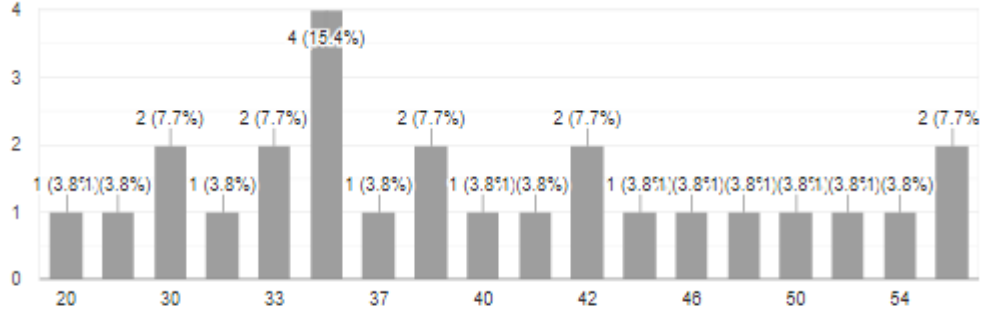
APPENDIX E

SCREENSHOTS FOR SURVEY QUESTIONS



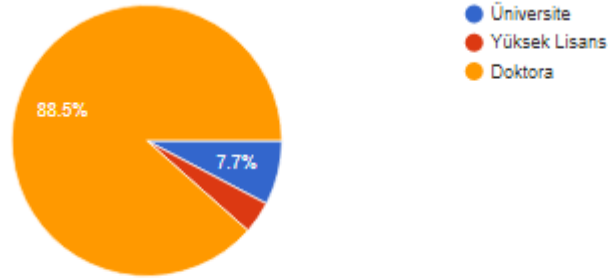
Yaşınız kaçtır?

26 responses



Tamamladığınız en yüksek eğitim seviyesi nedir?

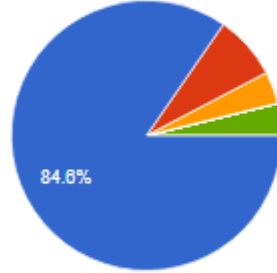
26 responses



Aşağıdakilerden hangisi mevcut mesleğinizi en iyi şekilde tanımlar?



26 responses

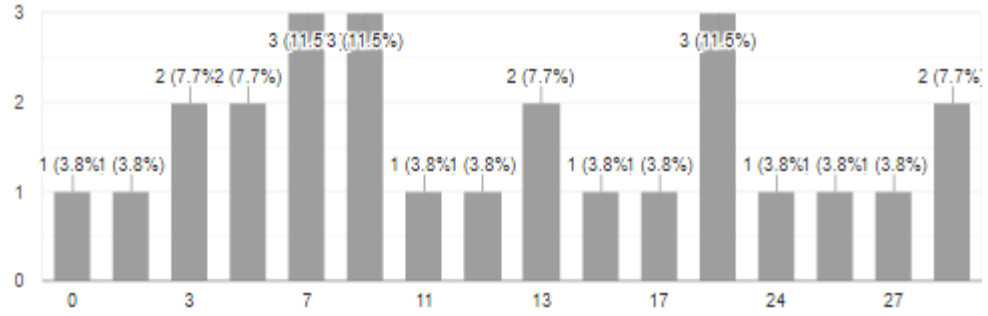


- Akademisyen
- Eğitim uzmanı
- Öğretim Teknolojileri Uzmanı
- Bilgi işlem yöneticisi
- Programcı
- Sistem yöneticisi
- Öğretmen
- Öğretim teknolojileri uzmanı ve öğretmen

Mesleki tecrübeniz (yıl olarak)



26 responses

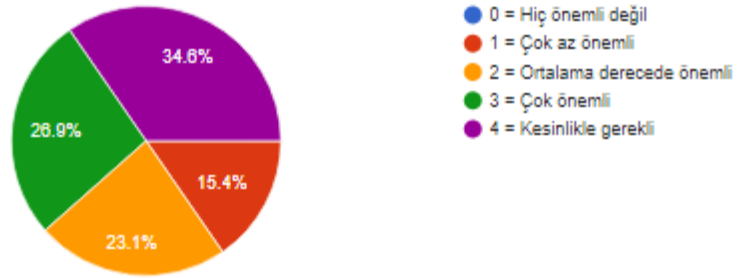


Öğrenme Yönetim Sistemleri için Değerlendirme Kriterleri

I. Sistem yönetimi ile ilgili kriterler

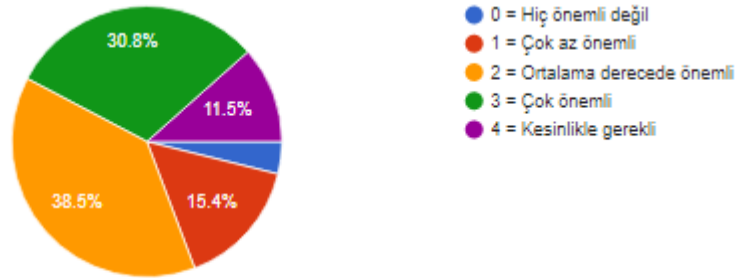
1- Kurulum kolaylığı (yazılımı kolayca, zorlanmadan veya efor sarf etmeden yükleme)

26 responses



2- Kurulum süresi (sistemi kurmak için gerekli süre)

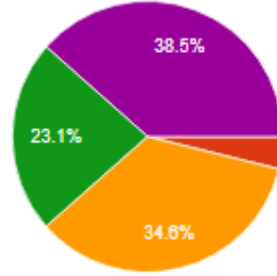
26 responses



3- Hata raporlama özelliđi (sistemde görünen tüm hatalar için rapor oluřturma)



26 responses

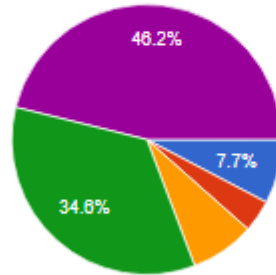


- 0 = Hiç önemli deđil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

4- İşletim Sistemleri (OS) uyumluluđu (Linux, Windows veya Mac gibi çeřitli işletim sistemlerini destekleme yeteneđi)



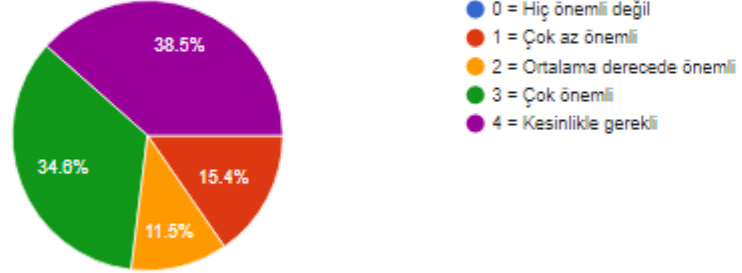
26 responses



- 0 = Hiç önemli deđil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

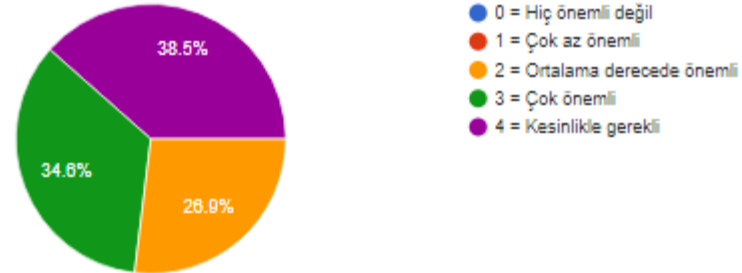
5- LDAP Entegrasyonu (Active Directory / LDAP Entegrasyonu kullanarak kullanıcı kimlik doğrulaması yapabilme)

26 responses



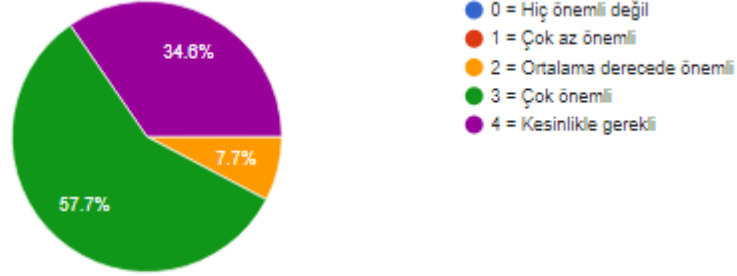
6- Sistem güncelleme özelliği (ÖYS'nin güncelleme alma ve kendini otomatik veya manuel olarak yükseltme özelliği)

26 responses



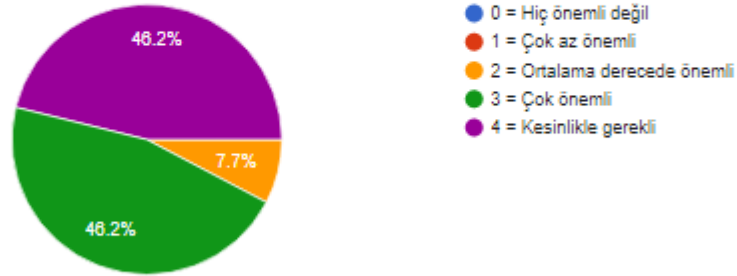
7- Bakım ve yükseltme (Düzenli aralıklarla ÖYS'nin bakımı ve yeni özelliklerin eklenmesi)

26 responses



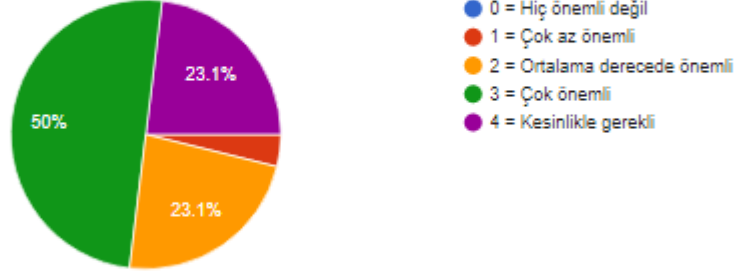
8- Uygulama programlama arayüzü (API) (Kullanım kolaylığı ve etkileşimi teşvik etmek için, LMS ve diğer yazılım sistemlerinin en iyi kullanıcı deneyimini sağlamak için birlikte çalışabilmesi gerekir)

26 responses



9- Üçüncü taraf desteği (derse daha iyi materyaller ekleyebilmek için ÖYS üçüncü taraf yazılımlarını desteklemelidir)

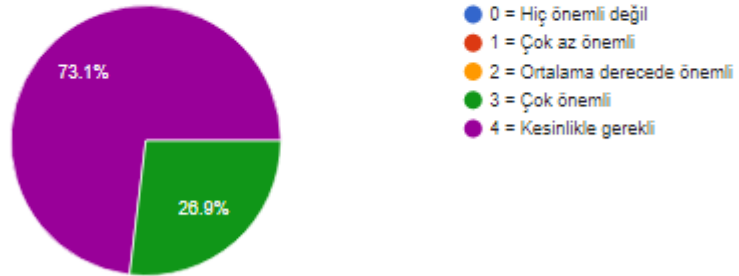
26 responses



II. Güvenilirlik ile ilgili kriterler

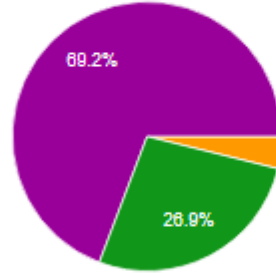
1- Yedekleme ve kurtarma özelliği (ders materyalleri için yedekleme yapmak ve gerektiğinde bunları geri yüklemek)

26 responses



2-Hata eğilimli olmaması (birim zamanda oluşan hata/çökme sayısının az olması)

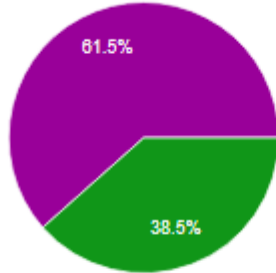
26 responses



- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

3-Doğruluk (Başarısız görevlerin başarılı görevlere oranının düşük olması)

26 responses

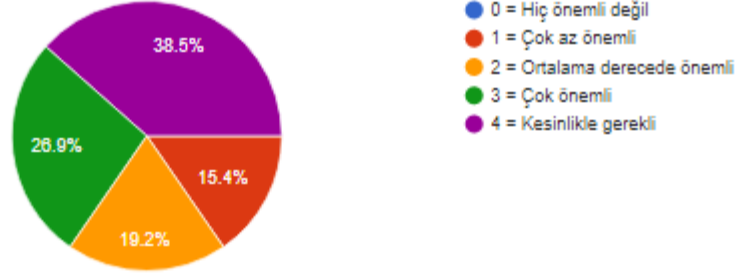


- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

III. Kullanılabilirlik ile ilgili kriterler

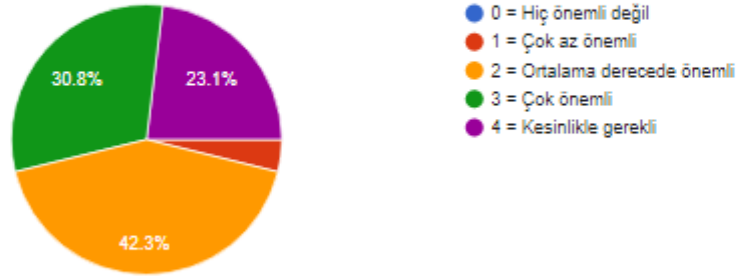
1- Teknik uzmanlık gerekmemesi (yazılımı kurmak ve kullanmak için uzmanlık seviyesinde teknik beceri gerekmemesi)

26 responses



2- Otomatik düzeltme özelliği (bağlantıdaki veya verilerdeki kullanıcı hatalarını veya yazım hatalarını düzeltme yeteneği)

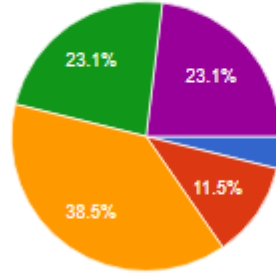
26 responses



3- Sezgisel kullanıcı arabirimine sahip olma özelliği (kullanıcılar, kullanıcı arabiriminin davranışını ve etkisini neden, deney, yardım veya özel eğitim kullanmadan anlar)



26 responses

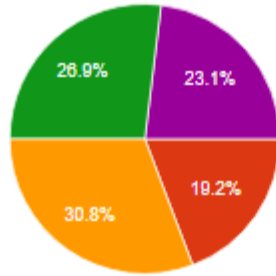


- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

4- Çok dilli site desteği (her dil için sayfalar oluşturma ve kullanıcıların kendi dillerinde gezinmelerine yardımcı olacak şekilde düzenleme yeteneği)



26 responses

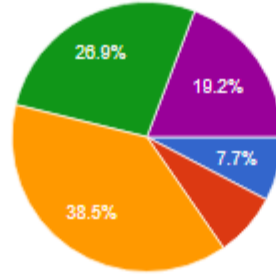


- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

5- Çöp kutusu desteği (Dersinizdeki bir yayını, sayfayı veya yorumu sildiğinizde, çöp kutusuna taşınır. Yayınlar, sayfalar ve yorumlar için ayrı bir çöp kutusu klasörünüz vardır. Bu özellik, bir yayını veya sayfayı yanlışlıkla silmeyi oldukça zorlaştırır)



26 responses

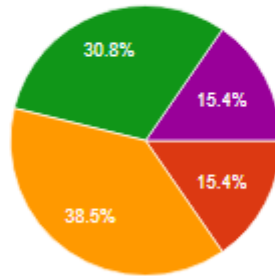


- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

6- Sıkıştırılmış dosya yükleme özelliği (Birden fazla klasör yüklemek için tek bir zip dosyasına sıkıştırılmaları gerekir; bunlar daha sonra yüklenebilir ve otomatik olarak hedef klasöre çıkarılabilir)



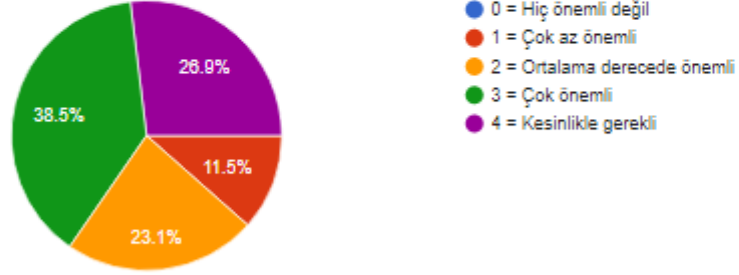
26 responses



- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Absolutely essential / Kesinlikle gerekli

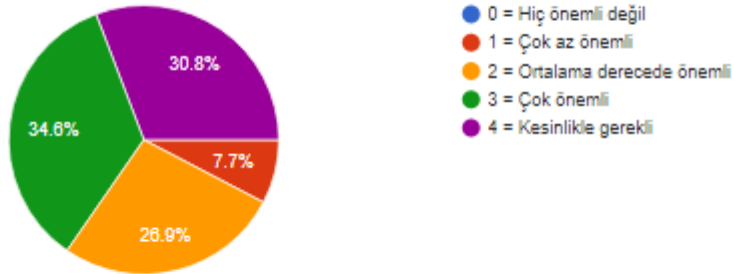
7- Kullanıcı dostu URL özelliği (Bir kullanıcı dostu URL, okunması kolay ve web sayfasının içeriğini tanımlayan kelimeleri içeren bir Web adresidir. Bu tür bir URL iki şekilde "kolay" olabilir. 1) Ziyaretçilerin Web adresini hatırlamasına ve 2) sayfanın arama motorlarına tanımlanmasına yardımcı olabilir)

26 responses



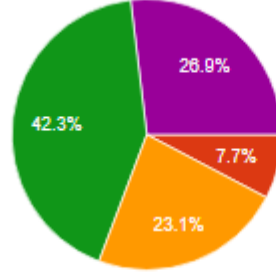
8- Çözünürlüğe duyarlı görüntü desteği (Çözünürlüğe duyarlı görüntüler otomatik olarak ekran boyutuna uyacak şekilde ayarlanır)

26 responses



9- Geri Al-Tekrar yap işlevselliği (yaptığımız hatayı giderme yeteneği)

26 responses

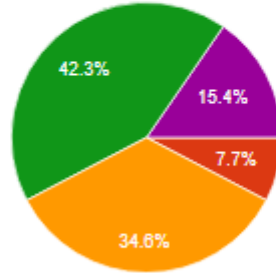


- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

10- Meta Veri / Etiketler desteği (Meta veri ve etiketler, yazar, anahtar kelimeler, açıklama, belge türü, telif hakkı ve diğer temel bilgiler gibi web sayfasıyla ilgili bilgileri listeler)



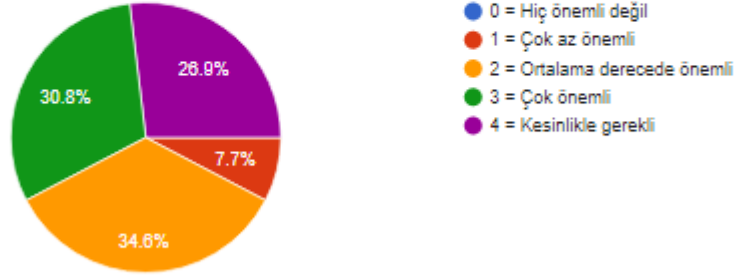
26 responses



- 0 = Hiç önemli değil
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- 3 = Çok önemli
- 4 = Kesinlikle gerekli

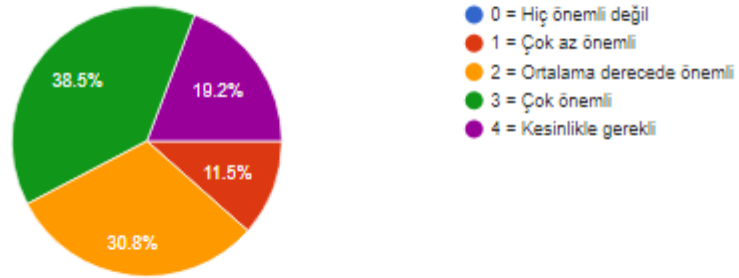
11- Sürükle ve Bırak desteği (sürükle ve bırak ifadesi, metnin veya bir nesnenin bir bölümünü seçme, onu taşıma (sürükleme) ve sonra onu alternatif bir alana yerleştirme (bırakma) eylemini tanımlamak için kullanılır. Ders içeriğinde değişiklik yapmayı oldukça kolaylaştırır)

26 responses



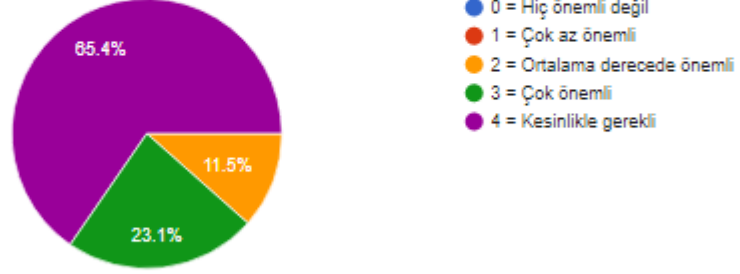
12- Yazım denetimi özelliği (ders içerisindeki yazım hatalarını otomatik olarak denetleme)

26 responses



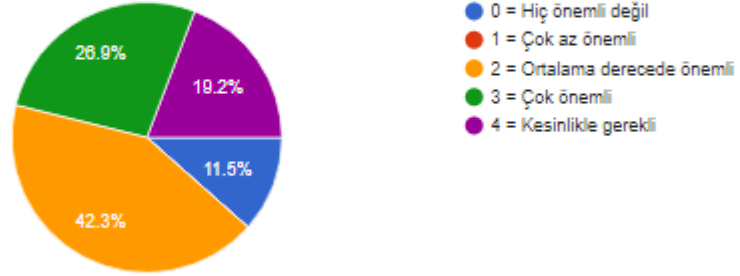
13- Mevcut tarayıcıları destekleme (Internet Explorer, Google Chrome, Mozilla Firefox, Apple Safari, Microsoft Edge üzerinde hatasız çalışma özelliği)

26 responses



14- Kişiselleştirilmiş görünümleri destekleme (Kullanıcıların arayüzü kendi isteklerine göre düzenlemesine olanak sağlama)

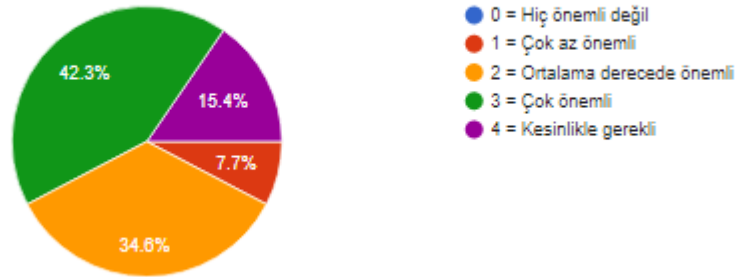
26 responses



IV. E-öğrenme standartları desteği ile ilgili kriterler

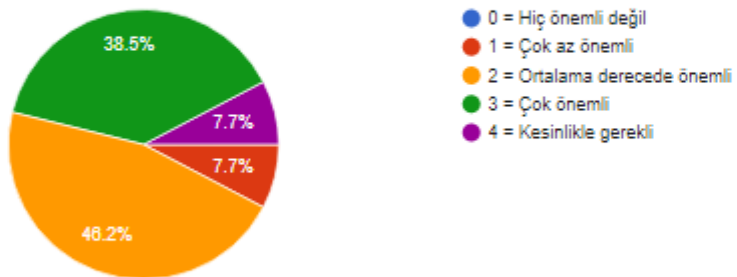
1- Tin Can API (xAPI) desteği (xAPI, bir kişinin çevrimiçi ve çevrimdışı eğitim etkinliklerinde yaşadığı çok çeşitli deneyimler hakkında veri toplamayı mümkün kılan güncel e-öğrenme standartıdır. xAPI'nin hem veri almak hem de göndermek için paylaşılan bir format kullanması, xAPI'yi çoklu sistemler arasında öğrenmeyi paylaşmak için ideal bir araç haline getirir)

26 responses



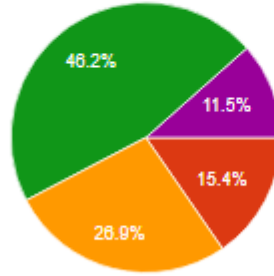
2- ADL SCORM desteği (Paylaşılabilir İçerik Nesnesi Referans Modeli anlamına gelen SCORM, xAPI standardının önceki sürümüdür)

26 responses



3- IMS Sorusu ve Test Birlikte Çalışabilirlik özelliği (QTI) desteği (IMS ve QTI aracılığıyla içerik geliştirme ve dağıtım sistemleri, depolar ve diğer öğrenme yönetim sistemleri arasında materyal alışverişini desteklemek için kullanılır)

26 responses

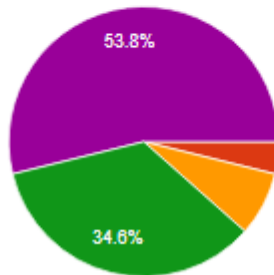


- 0 = Hiç önemli değil
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- 3 = Çok önemli
- 4 = Kesinlikle gerekli

V. Öğrenme analitiği ile ilgili kriterler

1- Öğrenci gelişimi ile ilgili raporlar sunabilme (dersteki öğrenci başarıları ile ilgili tüm ayrıntıları içeren bir rapor sunma yeteneği)

26 responses

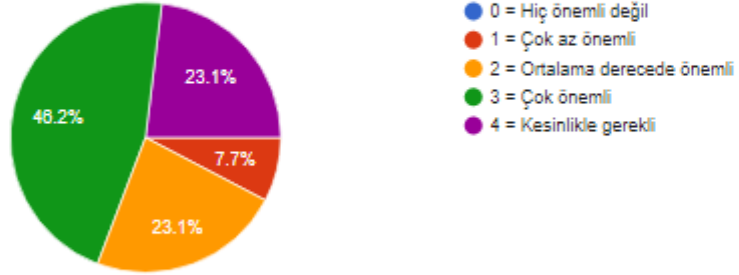


- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

2- Giriş tarihçesi ve analizi özelliği (ÖYS ziyaretçileri hakkındaki bilgileri analiz edebilme)

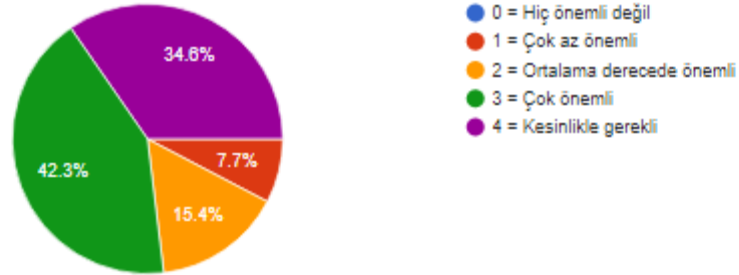


26 responses



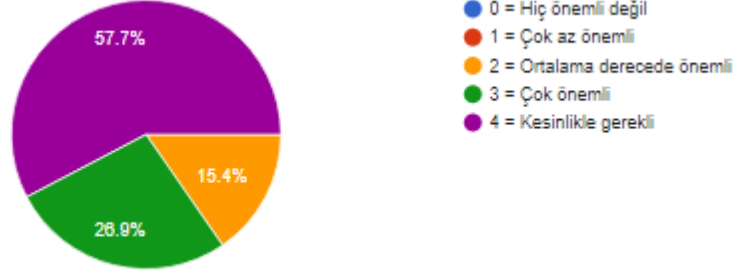
3- Zaman analizi özelliği (kurs içindeki tüm etkinliklerin ve trafiğin zamanını gözlemlemek için ders girişlerini analiz edebilme)

26 responses



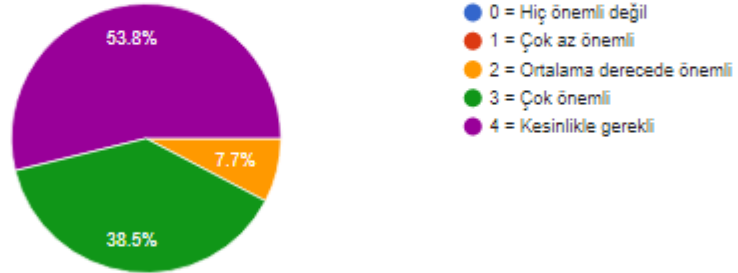
1- Kullanıcı türleri desteği (farklı kullanıcı türleri için farklı izinler verebilme)

26 responses



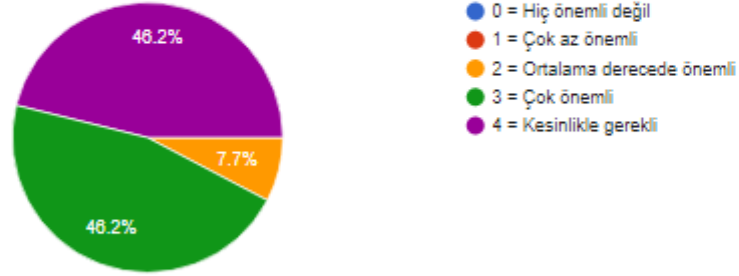
2- Veri girişi doğrulama özelliği (giriş doğrulama filtresi, ÖYS'yi korumak için yapılandırılabilir kurallarla ilk savunma hattı olarak görev yapar)

26 responses



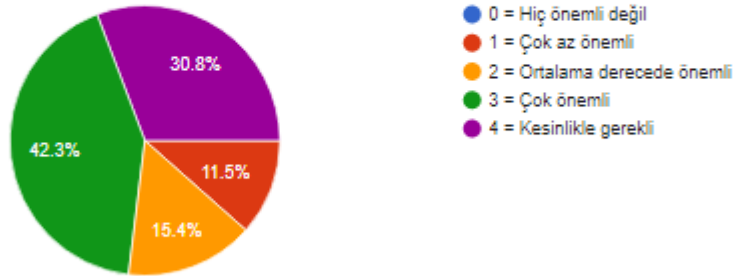
3- Veri / belge şifrelemesi özelliği (Bilgi ve veri merkezi, kurs / kullanıcı verilerinin güvenliğini sağlamak için şifreleme tekniklerini "kullanabilmelidir")

26 responses



4- CAPTCHA desteği ("bilgisayarları ve insanları ayırmak için tamamen otomatik halka açık Turing testi", kullanıcının insan olup olmadığını belirlemek için kullanılan bir tür soru-cevap testidir)

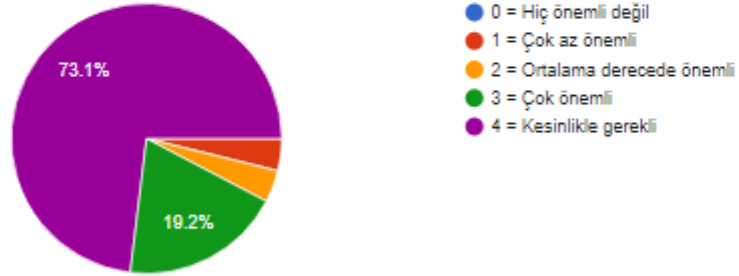
26 responses



5- Güvenli Bağlantı Katmanı (SSL) sertifika desteği (SSL, web siteleri tarafından LMS ve ziyaretçileri arasındaki bağlantıyı güvence altına almak için kullanılan bir şifreleme teknolojisidir. Kredi kartı numaraları veya giriş bilgileri gibi hassas bilgileri korumak için kullanılır)

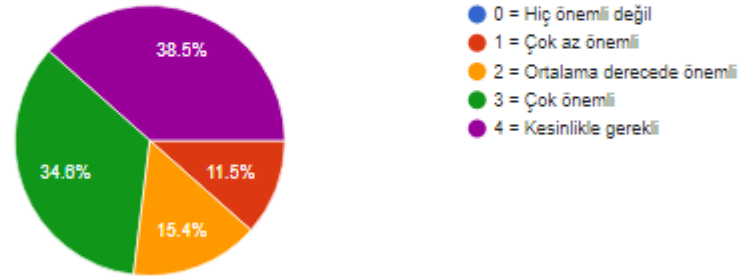


26 responses



6- Eposta doğrulama özelliği (e-posta göndermek için kullandığınız e-posta adresinin sahibi olduğunuzdan emin olmak için kullanılan doğrulama yöntemidir)

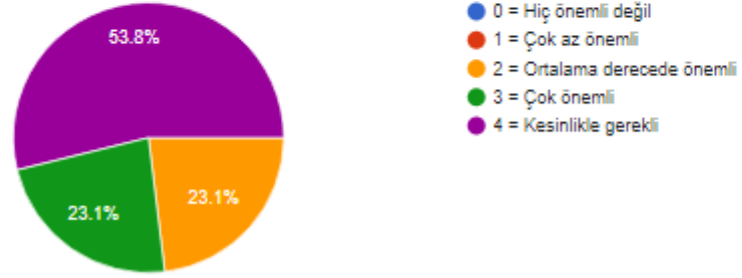
26 responses



VII. İletişim ile ilgili kriterler

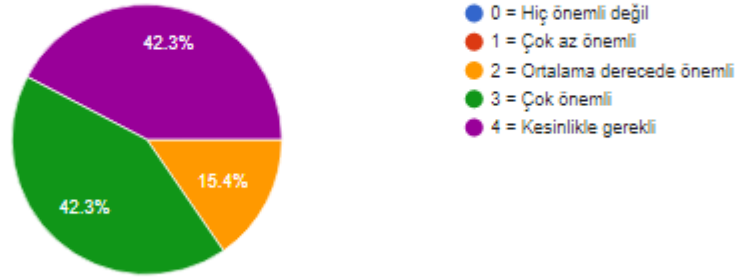
1- CANLI Video Konferans / Web Semineri özelliği

26 responses



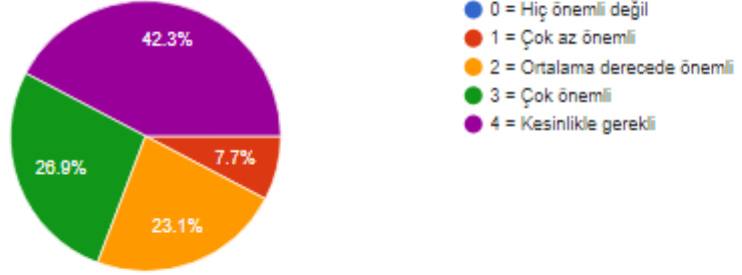
2- Direk iletişim özelliği (kursun içindeki kullanıcılar arasındaki iletişimi doğrudan iletilerle yapabilme)

26 responses



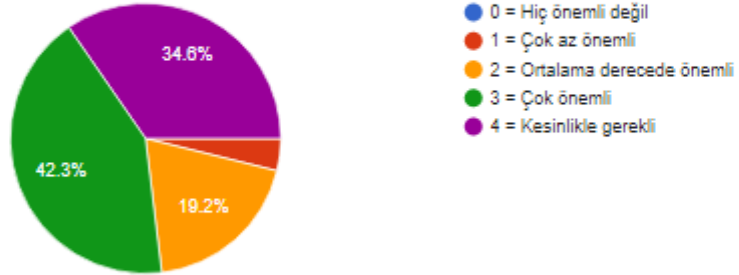
3- Forum özelliđi (kullanıcıların ders konularını tartışması ve ders hakkında ek bilgi edinmesi için bloglar)

26 responses



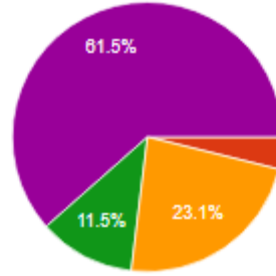
4- Beyaz Tahta (çevrimiçi sınıftaki konuların açıklamasını yazmak için bir ders tahtası sağlar)

26 responses



5- Dosya paylaşımı (dosyaları öğrencilerle veya öğrenciler arasında paylaşma yeteneği)

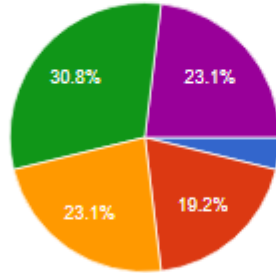
26 responses



- 0 = Hiç önemli değil
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- 3 = Çok önemli
- 4 = Kesinlikle gerekli

6- Dahili e-posta (eğitmen ve LMS ortamındaki öğrenciler arasında bir e-posta gönderme hizmeti sağlama)

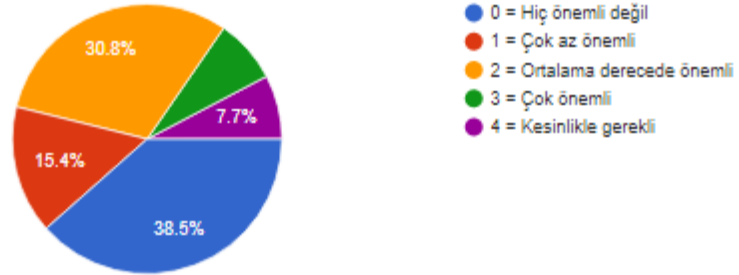
26 responses



- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

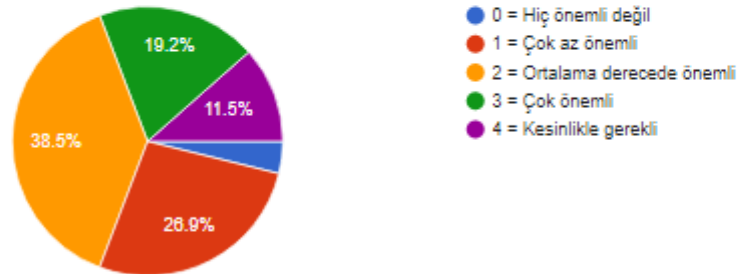
7- Facebook entegrasyonu (ÖYS'yi Facebook'a bağlayabilme ve LMS'nin içinden açabilme)

26 responses



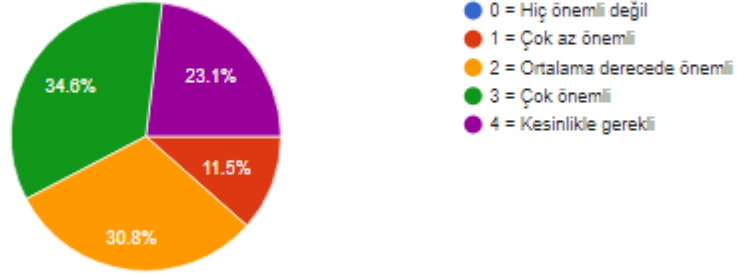
8- Web push bildirimleri desteği (Web push bildirimleri bir web sitesinden gelen mesajlardır. İlgili web sayfası tarayıcınızda açık olmasa bile bunları masaüstünüze veya cihazınıza alabilirsiniz. Ziyaretçilerinizi e-postalarını veya diğer iletişim bilgilerini bilmeden yeniden sitenize davet etmek için yeni bir duyuru kanalıdır)

26 responses



9- Yorum desteđi gönderme (kullanıcılara cevap verme ve kullanıcının sorusu veya açıklaması için yorum gönderme yeteneđi)

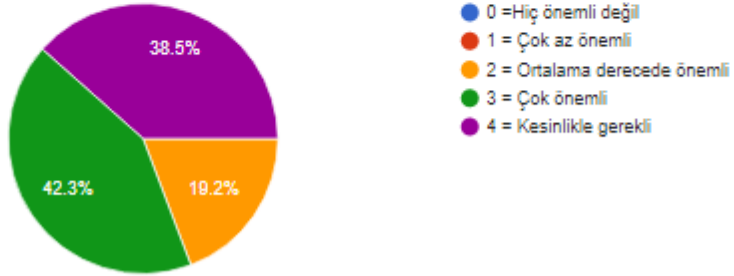
26 responses



VIII. Yazarlık araçları ile ilgili kriterler

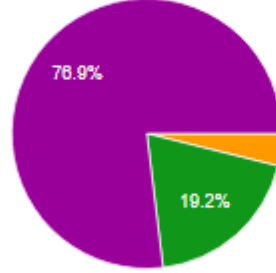
1-Link ekleme (ders içinde geçen kelimeleri Wikipedia gibi başka bir kaynaktan referans sayfasına veya materyale bağlayabilmek)

26 responses



2- Ders oluřturma / silme (yeni dersler oluřturabilme ve silme)

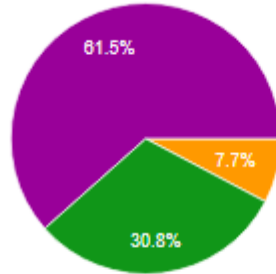
26 responses



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- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

3-Kaynak paketlerini yükleme-indirme (ders için gerekli materyallerin yüklenebilmesi ve indirilebilmesi)

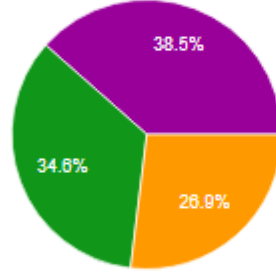
26 responses



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- 1 = Çok az önemli
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- 4 = Kesinlikle gerekli

4- Ders şablonu (ders şablonları kullanarak dersler oluşturabilme)

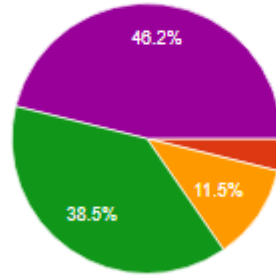
26 responses



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- 3 = Çok önemli
- 4 = Kesinlikle gerekli

5- Öğrenme sırasında etkileşimli aktiviteler sunabilme (Öğrencinin öğrenme sırasındaki videolar veya animasyonlar gibi çeşitli etkinliklerle etkileşime girebilmesi)

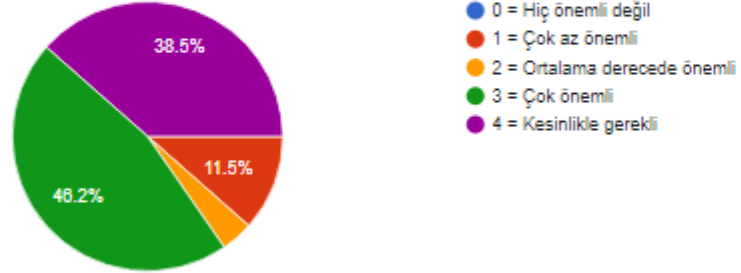
26 responses



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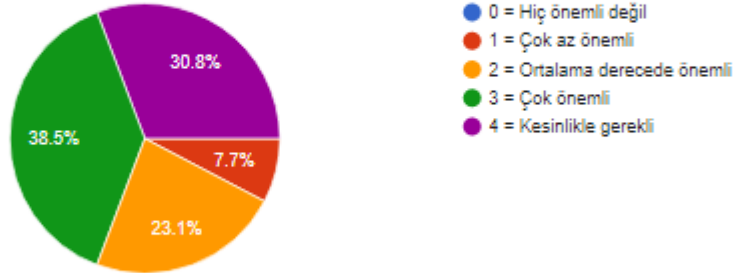
6- Çevrimiçi sınav editörü (ders için sınavlar oluşturmak amacıyla bir editör sağlama yeteneği)

26 responses



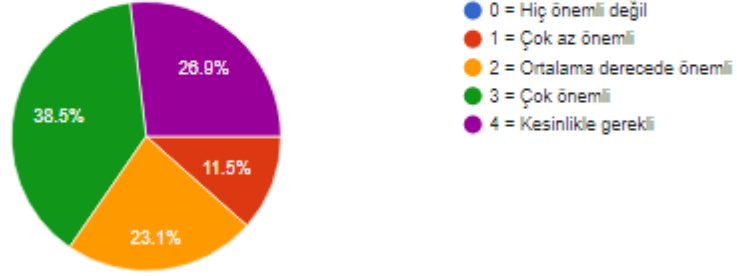
7- Genişletilebilir sınav motoru özelliği (daha fazla ek özellik ile sınav oluşturmayı kolaylaştırmaya yardımcı olan bir araç sağlama yeteneği)

26 responses



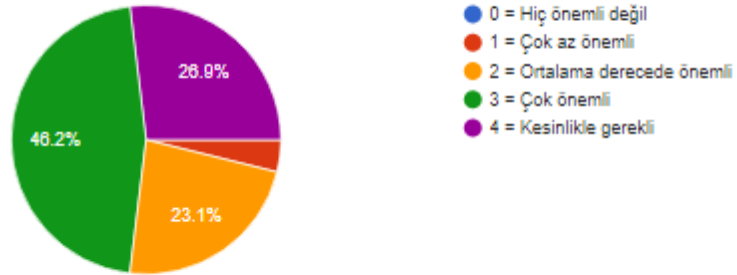
8- Kısa sınavları içe aktarma (başka derslerden kısa sınavları içe aktarma yeteneği ile soruların yapısını değiştirmeden yeni bir sınav oluşturabilme ve böylece gerekli çabayı ve süreyi azaltabilme)

26 responses



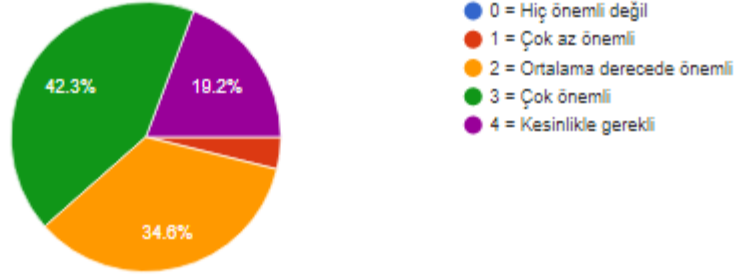
9- Yerleşik içerik geliştirme editörü (ders içeriğini çok fazla zaman harcamadan kolayca oluşturma becerisi)

26 responses



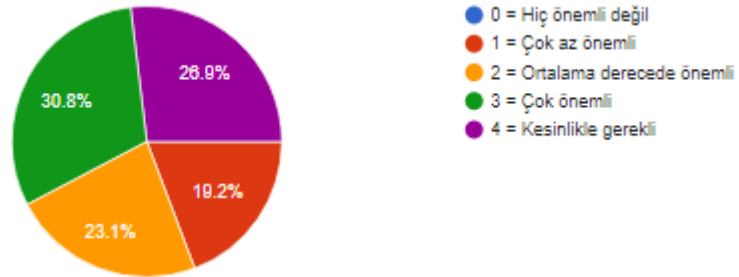
10- Yayın zaman programı oluřturma özelliđi (Planladığınız her ierik iin bir zaman semek yerine, sistem tek bir seferde bir yayın zaman programı oluřturmanıza izin verebilmelidir)

26 responses



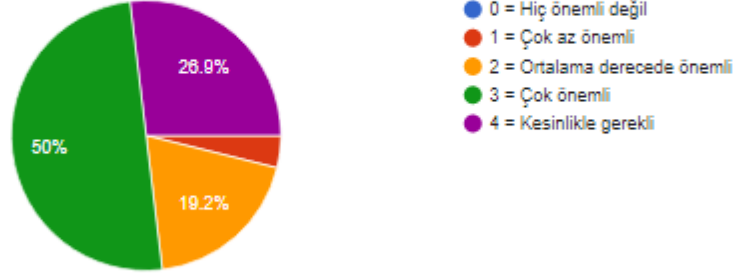
11- Oyunlařtırma desteđi (rozetler (En: badges), panolar, lider tablosu ve puanlar dahil olmak üzere oyunlařtırma özellikleri sunabilmesi)

26 responses



12- Youtube entegrasyonu (ÖYS'yi Youtube'a bağlayabilme ve ÖYS'nin içinden açabilme)

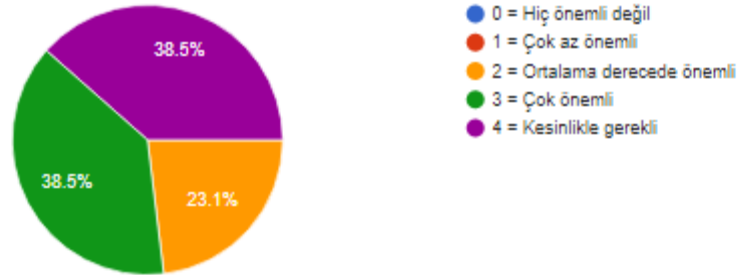
26 responses



X. Değerlendirme ile ilgili kriterler

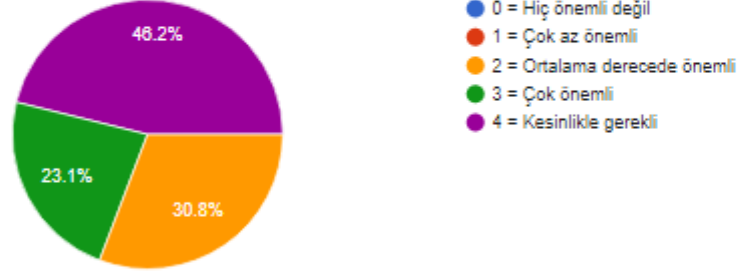
1- Öğrenciye öz-değerlendirme yapabilme (öğretim elemanındaki yükü azaltmak için çoktan seçmeli sorular gibi farklı sınav türlerini otomatik olarak değerlendirme ve öğrencinin anında geri bildirimle farklı sınav türleriyle öğrenmesine yardımcı olma yeteneği)

26 responses



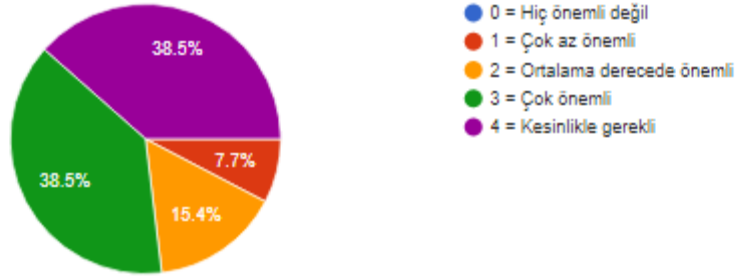
2- Çevrimiçi notlandırma özelliği (otomatik notlandırma sistemi ile öğrenciye derslerinde fiziksel malzeme olmadan notlarını sağlama kabiliyeti)

26 responses



3- Transkript ve sertifikalar (öğrencinin dersi tamamladığını ve öğrencinin öğrenme sırasındaki ilerlemesi hakkında bilgi sunması için gereken bir transkript veya sertifika sağlama yeteneği)

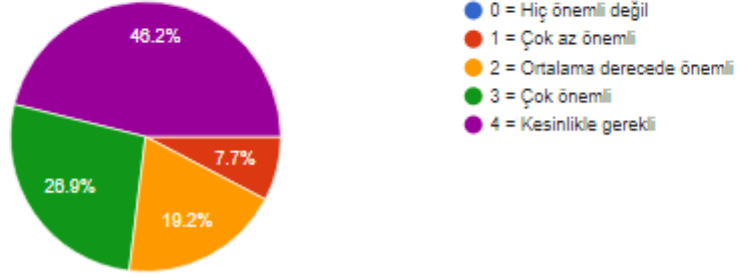
26 responses



1- Yazılım Dokümantasyonu (ÖYS'nin nasıl çalıştığını açıklayan belgelerin mevcut olması)

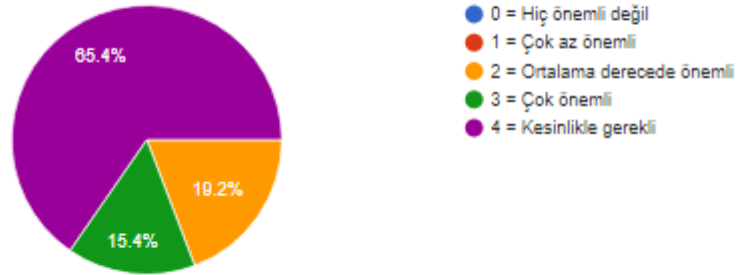


26 responses



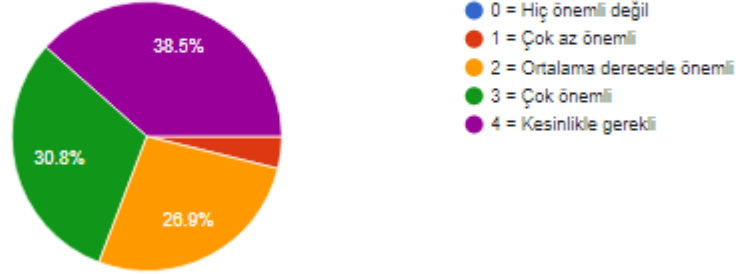
2- Kullanım kılavuzu / (ÖYS'nin nasıl kullanılacağını açıklayan uygulamalı yönergelerin yer aldığı kılavuzun mevcut olması)

26 responses



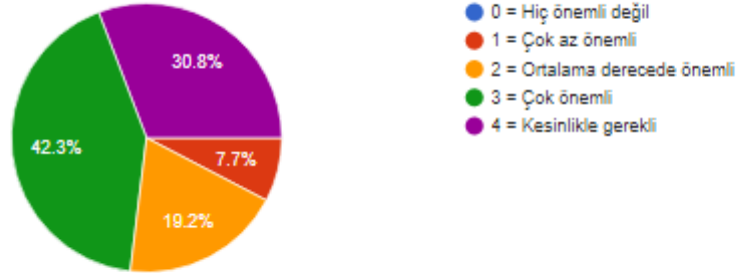
3- Çevrimiçi öğretici / (örnekler üzerinden öğretmeyi ve belirli bir görevi tamamlamak için bilgileri sağlamayı amaçlayan çevrimiçi öğreticiye sahip olması)

26 responses



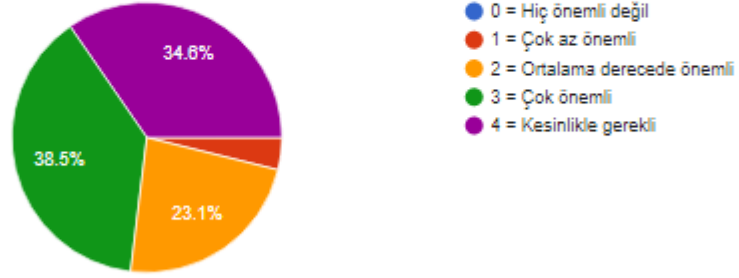
4- Topluluk desteği (ÖYS'nin geliştirilmesine ve sorunların çözülmesine yardımcı olabilecek bir topluluk destek hizmetlerine sahip olması)

26 responses



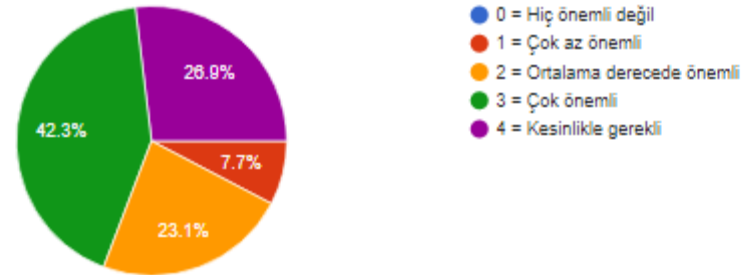
5- Sıkça Sorulan Soruların Cevapları (ÖYS kullanıcıları tarafından destek ekibine en sık sorulan soruların toplanması ve bu soruların cevaplarının sağlanması)

26 responses



6- Sorun giderme kılavuzu (Sorun giderme kılavuzu, kullanıcı topluluklarında ortaya konan genel sorunları ve çözümleri listeler)

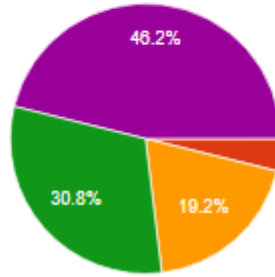
26 responses



IX. Ders yönetimi ile ilgili kriterler

1- Çevrimiçi kurslar için katılımcı yönetimi (kurs yöneticisinin, öğrencinin çevrimiçi kursta etkileşimde bulunmasına veya cevap vermesine izin verme yeteneği)

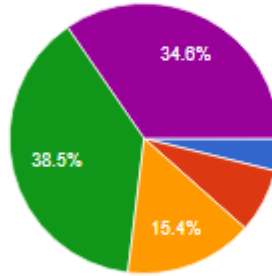
26 responses



- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli

2- İçerik sürüm takibi özelliği (içeriklerde yapılan tüm değişikliklerin izini sürebilme, önceki sürümlerini görüntüleyebilme)

26 responses



- 0 = Hiç önemli değil
- 1 = Çok az önemli
- 2 = Ortalama derecede önemli
- 3 = Çok önemli
- 4 = Kesinlikle gerekli