Web-based education in Spanish Universities.
A Comparison of Open Source E-Learning Platforms.

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ABSTRACT

Web-based education or 'e-learning' has become a critical component in higher education for the last decade, replacing other distance learning methods, such as traditional computer training or correspondence learning. The number of university students who take on-line courses is continuously increasing all over the world. In Spain, nearly a 90% of the universities have an institutional e-learning platform and over 60% of the traditional on-site courses use this technology as a supplement to the traditional face-to-face classes. This new form of learning allows the disappearance of geographical barriers and enables students to schedule their own learning process, among some other advantages. On-line education is developed through specific software called 'e-learning platform' or 'virtual learning environment' (VLE). A considerable number of web-based tools to deliver distance courses are currently available. Open source software packages such as Moodle, Sakai, dotLRN or Dokeos are the most commonly used in the virtual campuses of Spanish universities. This paper analyzes the possibilities that virtual learning environments provide university teachers and learners and offers a technical comparison among some of the most popular e-learning learning platforms.

Keywords: Web-based education, E-learning platforms, Virtual Learning Environments, VLE, Universities, Spain.

1. INTRODUCTION

Distance education by means of correspondence printed materials and audiovisual broadcasting was developed in the nineteenth century, with the aim of providing education to those students who, for several reasons, were not able to physically attend face-to-face traditional classes [1-4]. The University of London was the first mainstream university to offer distance-learning degrees in 1858. Some years later, in 1969, The Open University was founded in the United Kingdom as a pioneer institution exclusively devoted to provide distance higher education. Many other distance-universities were established through the globe in the 70's and 80's, including the Athabasca University in Canada (1970), Spain's Public University of Distance Education (UNED) (1972), the FernUniversität (FEU) in Germany (1974), the CCCTV in China (1978), the Open University of the Netherlands (1981) and the Open University of Japan (1984), among others. More than a dozen of these universities have grown at present to become institutions with more than 100,000 students. The Indira Gandhi National Open University in India is currently the largest university in the world with more than 3,000,000 students [5].

In the 90's, distance learning technologies evolved toward Computer Based Training Methods (CBT). The use of multimedia resources (text, images, videos, animations, etc.) distributed on floppy disks or CD-ROMs, which students could use in their computers, meant a significant advance in distance education. Nevertheless, their high price, fast obsolescence and difficulties to upgrade the contents were the main drawbacks of these techniques [6]. At the end of the 90's the Internet began to be used in distance education. Online web-based courses offered two fundamental advantages against conventional computer courses mentioned above: (i) learning could be made at any place with an Internet connection, and (ii) teachers could easily manage and upgrade learning materials via the web, as these ones are placed in a server called LMS (Learning Management System) [7]. The number of university students who take on-line courses is continuously increasing all over the world. In the US for example, over 5.6 million university students took at least one online course in the fall 2009 term. This figure means a 30 per cent of the total enrolled university

students in this country and an increase of nearly one million students over the previous academic year [8].

The terms 'distance learning' and 'distance education' are currently used to refer to a wide range of learning experiences that include both online courses completely delivered through the Internet (called 'virtual learning' or 'e-learning') and those others that combine traditional teaching in a physical classroom with virtual learning techniques (called 'blended learning' or 'b-learning') [9-11].

These new forms of distance learning allow the disappearance of geographical barriers and enable university students to access learning contents on their own schedule. Instructors and learners interaction is possible thanks to the use of synchronous (videoconferences, real time chats, whiteboards, etc.) or asynchronous (e-mails, blogs, wikis, podcasts, or discussion forums, etc.) communication tools [11].

The instructor plays a leading role in a traditional educational scheme, as he is responsible for preparing and giving classes, developing teaching materials, preparing evaluation tests, etc. In virtual education, however, these roles usually fall on a teaching team, while students play a dominant role as they must manage their own learning process. Two crucial aspects must be conscientiously considered in order to optimize a virtual learning model: the educational quality of the learning materials to be used and the emphasis on providing personalized assistance to the students. Specific software called e-learning platform or virtual learning environment can be helpful to achieve these aims.

Table 1 summarizes the advantages and disadvantages of Internet-based learning methods compared to traditional one based on 'on-site' lessons physically delivered in a classroom.

Table 1. Advantages and disadvantages of e-learning methods compared with traditional teaching.

Advantages	Disadvantages
Time and geographic flexibility.	Lack of face-to-face contact between the instructor and the students.
Avoiding travel costs.	Additional efforts and dedication of the teacher are required.
Course contents are permanently available.	
Course information and learning contents are easy to update.	Computer skills of teachers and students are required.
E-learning promotes learners autonomy.	On-line courses require motivated and autonomous students.
It is based on multimedia learning contents.	
Collaborative work among teachers is promoted.	Student assessment and feedback is limited.
Student activity and learning progress are automatically recorded.	Online courses usually have higher rate of abandonment.
Development of skills and competencies in ICT	A fast Internet connection is required.

2. VIRTUAL LEARNING ENVIRONMENTS: TECHNICAL FEATURES AND POSSIBILITIES FOR DISTANCE LEARNING

An e-learning platform is a software package installed in a server and accessed through the Internet that allows teachers to create, manage and give online courses or to deliver complementary learning materials for face-to-face education [12-15]. A wide range of terms can be used to define this concept, such as: Virtual learning environment (VLE), Learning Management System (LMS), Course Management System (CMS), Managed Learning Environment (MLE), Integrated Learning System (ILS), Learning Support System (LSS) or e-learning platform (LP).

According to [14], an e-learning platform should have at least the following utilities (Figure 1):

Figure 1. Main utilities of an e-learning platform.

(i) tools for managing and editing the learning materials and the structure of a virtual course (i.e. course templates, labels, files manager, links, glossaries, FAQs, etc.).
(ii) synchronous and asynchronous communication tools (i.e. discussion forums, real-time chat, electronic bulletin board, internal e-mail, virtual whiteboard, videoconference utilities, etc.).
(iii) tools for monitoring and assessing the learning processes (i.e. test editor, file exchange system, student tracking utilities, online gradebook, etc.).
(iv) administration tools (i.e. authentication and authorization tools, configuration options, course calendar, etc.).
(v) additional resources, such as search engines, statistics, etc.

A virtual learning environment must operate under a 'client-server' philosophy that allows users to access the learning contents through a standard web browser without requiring the installation of other specific software. It should also provide an intuitive graphical interface that avoids users to waste unnecessary time to learn how to use the system. The possibility of distributing multimedia documentation and their functionality with different operating systems (PCs, Mac, Unix, etc.) are also important questions to be considered when selecting an e-learning platform [16].

Virtual learning environments offer the following possibilities for higher education:

Distribution of course information and teaching materials: A virtual learning environment allows students enrolled in a course to access the necessary information about the schedule, list of topics, recommended bibliography, tutorials, etc. Students may also access and download through the web learning materials, such as texts, mathematic equations, images, audios, videos, animations and others. Course contents can be organized in blocks or lessons and the lecturer can specify start and stop dates for each of them.

Dissemination of notices: VLEs allows instructors to email individuals, groups or the entire class specific notices regarding the development of the course. A 'course calendar', 'virtual bulletin board' and 'internal messaging service' are all versatile tools to inform the students. Notices are simultaneously available in the web and emailed to each of the students enrolled in the course. The e-learning platform also informs students about the marks they have obtained in the assignments and the assessment tests.

Discussion forums: This tool can be used to suggest discussion topics or to solve queries in a participatory way. Once a debate topic has been raised in a forum, instructors and students can take part and express their opinions, being responses available to any interested student.

Submission of tasks: The e-learning platform can be used to suggest individual and group assignments to the students that they must submit online. On the one hand, the platform enables the instructor to access the files uploaded by the students, to review them and to grade the task, and on the other hand students can access the corrections and check their marks.

Assessment of learning progresses: VLEs usually provide tools for developing online assessment tests (Fig.2). The assessment module of an e-learning platform must allow teachers at least four basic actions: (i) to develop different types of tests, such as true/false, multiple choice, fill-in the blank, matching, ordering, etc., (ii) to set dates and times when students must take the virtual tests, (iii) the system must be able to randomize the questions and answers to be included in the test, and (iv) instructors can override the automated scoring and determine how to communicate test results to students.
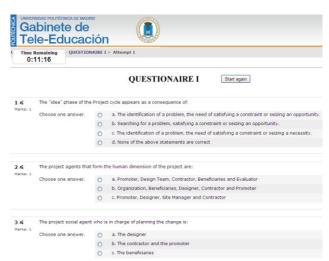

Figure 2. Assessment test developed with Moodle 1.9

Monitoring the activity of the students enrolled in a course: The virtual learning environment provides a list of the students enrolled in the course and basic information, such as photos or e-mails. Moreover, instructors can easily track the frequency and duration of each student access to individual course components, his participation in the discussion forums, or the assignments and tests he has carried out.

Virtual learning environments have evolved through the years giving rise to three different types of solutions: (i) commercial software, (ii) open source platforms, and (iii) internally developed platforms.

Commercial VLE software packages require the payment of an annual license fee for their use. Software providers usually offer technical assistance and some specific modules that improve the functionality of the platform, i.e. whiteboards, advanced course calendars, different kinds of assessment questionnaires, etc. Blackboard, WebCT (currently integrated with Blackboard) and e-College are some of the commercial VLE that can be included in this category.

Open source e-learning platforms can be customized and adapted by the user and are usually free of a license fee. Most of these applications were originally developed by universities and educational consortiums (Table 2) and are frequently updated and improved by their users. Although commercial e-learning software packages usually offer additional services, differences between both types of platforms are each time smaller and smaller. Some of the most popular virtual learning environments, such as Moodle, Dokeos, Claroline, ILIAS, dotLRN or Sakai belong to this group.

Finally, a great number of specific VLEs have been internally developed by research groups and educational institutions in order to meet the needs of a particular educational model. Nevertheless, many of them are being replaced at present by generic open-source software.

Table 2. Open source e-learning platforms.

CLAROLINE http://www.claroline.net 	The Claroline VLE was initiated in 2001 by the Catholic University of Louvain (Belgium). The software has been translated into 35 languages and is currently used by more than 1700 organizations from 101 countries. In Spain it is used by the University of Vigo.
DOKEOS http://www.dokeos.com 	This e-learning software is currently used by almost 300 universities around the world and there are more than 250,000 active Dokeos e-courses at present. It is available in 34 languages. The Dokeos VLE is institutionally used in Spain by the Antonio de Nebrija University.

dotLRN http://dotlrn.org	The .LRN software is an e-learning system developed at the Massachusetts Institute of Technology (MIT) in 2006. It is currently used by more than 500.000 users. DotLRN is used in Spain by the UNED, among some other universities.
ILIAS http://www.ilias.de	The ILIAS learning management system was developed between 1997 and 2000 at the University of Cologne. It is available in more than 20 languages and the user can choose among different interfaces and styles. It is used in Spain by the University of Jaén.
MOODLE http://moodle.org	Moodle was originally developed by Martin Dougiamas in Australia in 1999. Currently, it is the most used VLE throughout the world, with more than 2 million users. By December 2010, Moodle had a user-base of 39,868,035 users in 4,180,694 courses in more than 200 countries and in more than 70 languages. More than 1300 universities and high schools use this VLE in Spain for delivering distance courses or as a supplement to the traditional classes
SAKAI http://sakaiproject.org	The earliest versions of Sakai were originally developed at the Michigan and Indiana Universities. At present, the Sakai Foundation is constituted by more than 100 international universities, colleges and commercial affiliates. The University of Lerida and the Universidad Politécnica of Valencia institutionally use this software in Spain.

3. USE OF VIRTUAL LEARNING ENVIRONMENTS IN SPANISH UNIVERSITIES

For the last quarter of the 20th century and the early years of this century there has been a significant increase in the number of university students throughout Europe. The Higher Education System in Spain is presently formed by 1.5 million students, what means the twenty five percent of the population aged from 18 to 24. There are 78 universities: 50 of them are public universities and the remaining 28 are private institutions. Approximately a 13 per cent of the Spanish students are enrolled in one of the 5 existing distance universities.

The number of university students in Spain has increased from 400.000 in the 70s to approximately 1.5 millions in the 90s, remaining more or less constant from then [17]. In addition, the demand for postgraduate education (masters, PhD courses, specialization courses, etc.) is also increasing among the young people and middle-age professionals.

The Information and Communication Technologies (ICTs) have being increasingly incorporated in Spanish universities for the last decade. According to the institutional report 'UNIVERSITIC: Evolution of the ICTs in Spanish Universities (2006-2010)', at present the 64% of the classrooms in Spanish universities have a multimedia projector and 86% of them are Wi-Fi areas [18].

The number of web-based courses delivered through VLEs has significantly increased during the last decade in both European and US universities. According to the UNIVERSITIC report almost the 90% of Spanish universities have an institutional e-learning platform and over 60% of the traditional on-site courses use it as an additional learning resource. The percentage of professors who use these tools in Spain has doubled (from 40% to 80%) for the last five years and the number of university students using them has increased from 62% to 90%.

The initial trend during the 90s was the use of commercial or internally developed VLEs. Nevertheless, open source solutions such as Moodle or Sakai are becoming more and more popular, as they are free of license fee and their features are becoming more and more like those of the commercial ones. According to a study conducted in 2008, 63% of the virtual campuses of Spanish universities use open source VLEs, while the remaining 37% used commercial or internally developed platforms or did not provide the required information. Moodle is the institutional e-learning platform in 53.8% of Spanish universities, followed at distance by Sakai (3.8%) [19]. Nevertheless, commercial software packages such as Blackboard or e-College continue being very popular in the US universities

4. TECHNICAL COMPARISON OF SOME OF THE MOST POPULAR VIRTUAL LEARNING ENVIRONMENTS

Several studies and technical comparisons of Virtual Learning Environments have been published in recent years [20-23]. The *EduTools Project*, developed by the British Columbia University and actually owned by the WCET (Western Cooperative for Educational Telecommunications), provides feature-by-feature comparisons among more than sixty e-learning platforms [24].

Although commercial or internally developed platforms were the most popular option during the 90s, at present there is an increasing trend toward the use of open source VLEs, such as Moodle, Sakai, Dokeos or dotLRN, as they offer more and more e-learning resources. The majority of these applications enable the course editor to customize the interface of the virtual course and/or to introduce institutional images, headers and footers. Some e-learning platforms like Dokeos, Sakai or dotLRN provide an initial menu from which users can access the different learning resources and utilities (learning materials, discussion forums, notices, tasks, assessment tests, etc.).

Moodle courses, however, are structured in modules or lessons, each of them may include its own multimedia learning materials, discussion forums, assignments, assessment tests and so on. (Fig. 3 and 4)
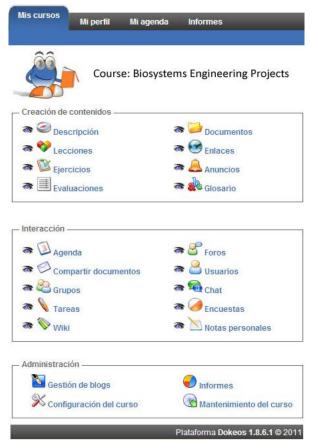

Figure 3. Options menu of an e-course created in Dokeos 1.8.

Figure 4. Structure of an e-learning course in Moodle 1.9.

Although most of the e-learning platforms enable teachers to form groups for collaborative learning activities, there are particular differences in their group work functionalities. Although nearly all the VLEs enable teachers to email a group specific notices and information, not all of them allow instructors to deliver specific assignments or assessment tests for a particular group not accessible to the rest of the class. The Sakai 2.5 e-learning platform, for example, assigns each group

a private folder that enables members to upload and download homework assignments and specific documentation. Some other e-learning software such as Moodle 1.9 or Dokeos 1.8 lacks this feature.

Generally, all the e-learning platforms allows instructors to include image, audio, video, animation files in the courses, although specific software must be installed in the user's computer to view them. The Blackboard Learning System and some other commercial platforms, however, do offer instructors the chance to integrate multimedia resources in the course (not only as files to download). The multimedia files of an e-course can be stored and organized into folders and subfolders. Files usually must be uploaded one by one, although some VLEs such as Sakai or dotLRN, for example, allow instructors to upload multiple files all at once.

Some of these e-learning platforms enable instructors to establish a learning pathway by specifying the start and stop dates for particular course contents or to personalize the access to specific course materials according to previous completed assignments, positive assessments and/or course activity. This last feature is full-offered by Dokeos 1.8 and only available for tasks and assessment tests in Moodle 1.9. Video conferencing and whiteboard tools (an electronic version of a dry-erase board) are also interesting resources to deliver distance classes. Nevertheless, these applications are only available in some commercial platforms such as Blackboard. The Sakai VLE has an interesting tool called 'Student's portfolio', which can be customized by each student and be used to present his/her course works or projects.

Most of the available VLEs incorporate communication and discussion tools such as forums, real-time chats and an electronic bulletin board that course administrators and/or teachers can use to announce events, or provide information. The dotLRN software, for example, enables students to choose if they want to receive alerts when any new course contents (i.e. files, tasks, evaluation tests, etc.) are incorporated into the platform. Most of the e-learning platforms offer instructors the chance to assign tasks to the students that they must submit online by asking in a box or uploading one or multiple files. The Sakai 2.5 VLE provides each user (teacher and students) a particular folder to share information with other users of the course.

The online assessment tools enable teachers to prepare and conduct online tests. In general, every VLE has a specific module to design different types of assessments (single answer tests, multiple choice tests, matching, ordering, fill-in the blanks, essays, etc.). The Dokeos assessment module is particularly intuitive and easy to use. VLEs also provide teachers the chance to track student activity and progresses. Instructors can get individual reports showing the frequency and duration of student access to individual course components, participation in the discussion forums and chat sessions and the assignments and assessment tests he/she has carried out. Statistical data about the activity of the class and the use of the various learning resources can also be collected and displayed.

5. CONCLUSIONS

Virtual learning environments have become an essential resource for distance learning and traditional on-site university

education. Over 80% of teachers in Spanish universities habitually use this kind of e-learning tools to deliver online courses or as an occasional supplement of traditional lecturing.

A considerable number of e-learning platforms can be found for the delivery of online education. This kind of software allows instructors: (i) to create, store, organize and distribute learning resources; (ii) to make communication easier between the instructors and the students, and (iii) to track and assess learning progresses and achievements of each particular student.

Open source e-learning platforms such as Moodle, Sakai, Dokeos and dotLRN are mainly used in Spanish universities. Although most of these VLEs have common resources such as synchronous and asynchronous communication tools or assessment test editors, there are certain differences among their features, which have been highlighted in this paper.

The Moodle platform, which is the most commonly used in Spanish universities, is organized around the course units or lessons that are placed in the central area of the web. Some other platforms like Dokeos, Sakai and dotLRN have a 'Start menu' from which it is possible to access the different learning resources (lessons, tasks, discussion forums, online gradebook, etc.). The Sakai platform offers some interesting options for collaborative learning and has an advanced student portfolio that can be used by the students to present their course projects. Dokeos offers an intuitive and useful tool to create assessment tests and the chance to establish access conditions to the different course materials. Sakai and dotLRN enable instructors to upload to the server multiple files all at once. Nevertheless, some interesting features such as integration of multimedia contents in the lessons, video conferencing tools and electronic whiteboards are only available in certain commercial platforms such as Blackboard.

Acknowledgements

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