Chapter IX

Using Open Source to Building and Accessing Learning Objects and Online Courses

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Abstract

As e-learning continuously gains the interest of the scientific community, industry, and government, a wide variety of learning technology products have been incorporated into the marketplace. Advances in information and communication technologies are in favor of the incorporation of innovative services and functionalities in such systems, though content creation and delivery remain the two key factors in any e-learning system. Therefore, in this chapter, we present the design and implementation of a tool targeted at building and accessing learning objects and online courses through the Web.

This tool aims to facilitate instructors and trainers to easily develop accessible, reusable, and traceable learning content that can meet their distant students' needs for anytime and anyplace learning. Learners are able to access learning content, in addition to consulting, at any time, reports on their interactions within a course and get support by subject experts. Furthermore, all users can request to upgrade their role in the system and, thus, actively participate in the learning process. Special attention has been paid on the utilization of reliable and qualitative open source technologies and Web standards so that the proposed solution can form an easily accessible system.

Introduction

Nowadays, the wide expansion of the Internet, in combination with the time and place limitations that traditional learning implies, as well as the current Web infrastructure, are in favor of the effective and efficient application of distance learning, otherwise e-learning. In many cases, actually, e-learning is used as a complement to face-to-face education in order to meet students' need for "anytime" (and/or "anyplace") learning.

Depending on whether learners interact in real time with their instructors and/or with each other, distance leaning is distinguished into asynchronous and synchronous learning. According to Midkiff and DaSilva (2000), synchronous and asynchronous distance learning classes each have their own strengths, which allow them to meet the needs of different markets. Asynchronous distance learning, though, gains the interest of a wider audience and thus, it is likely to grow at a faster rate than synchronous distance learning, due to its inherent flexibility and the ever-increasing bandwidth of Internet connections and capabilities of Internet applications. In this mode of learning, learners and instructor(s) can be separated in both time and space, and neither must be physically tied to anything except a computer and the Internet. More to the point, studies have shown that the achievements of individually tutored students may exceed that of classroom students. As a result, the majority of the up-to-date e-learning systems support, mainly, asynchronous distance learning in the sense of the asynchronous mode of learning content delivery. They include, though, some kind of real-time interaction among the users so that learners have the feeling that they are not isolated, but active members of a virtual community, and that they can get support whenever they need it.

Despite the different characteristics and services up-to-date e-learning platforms present, according to the pedagogical approach they follow for serving their end-users needs, as well as the technological solutions they adopt to support the learning

process, they are all organized into three fundamental macro components (Colace, De Santo, & Vento, 2002):

a.   a learning management system (LMS),

b.   a learning content management system (LCMS), and

c.   a set of tools for distributing training content and for providing interactions among users.

The elements shared by all LCMSs are (Wan, Zhao, Liu, & Sun, 2005) a learning-object repository; an authoring tool for creating learning objects; a dynamic publishing tool for delivering personalized-learning content; and an administration tool for providing management function. An advanced LCMS should, further, deploy and manage content that can be easily searched and retrieved during an auto-training phase and reused for different educational purposes (Bouras & Nani, 2004). To that end, learning resources would be described using metadata. Another functionality that LCMSs are expected to expose is the storage of the learners' interactions with the content. This enables the system to gather information about the content's usage, and report on learners' progress and performance.

As far as the LMS is concerned, this integrates all the aspects for managing online teaching activities. The LMS adds users, traces courses, stores data of the users, and generates reports for management, and it is designed to manage multiple courses (Álvarez-González, Sandoval, Ritter, & Berger, 2005). According to Colace et al. (2002), a state-of-the-art LMS should enable learners to consult, at any time, the results they have reached, and thus, monitor their preparation level. This information can be exploited by the system in an attempt to diagnose the learners' needs and advise them on the most suitable learning content.

The set of tools, lastly, is essential to differentiate the kind of provided services in accordance with the user. In particular, instructors should be provided with tools that will enable them to manage teaching processes for single individuals or groups, as well as all the interactions, including asynchronous discussions or live events. Instructors should also be provided with updated reports on the learners' performance in order to facilitate their activities. Above and beyond, it is necessary to allow learners to communicate, synchronously or asynchronously, with both the instructor and other members (Colace et al., 2002).

Overall, distance-learning platforms should present characteristics that make the training process functional and available, encouraging and accepting the learner autonomy and initiative. They should be Web based, run on many computers and operating systems and follow one or more learning technology specifications. Yet, the two key factors in any e-learning system, according to Jesshope and Zhang (2002), are content creation and delivery.

To that end, this chapter presents the design and development of a system targeted at **b**uilding and **a**ccessing **l**earning **o**bjects and **c**ourses through the Web (BALOC). BALOC is an LCMS that incorporates all the innovative features an up-to-date LCMS is expected to expose, but also integrates a number of services for managing online training activities (LMS functionality), as well as tools enabling the users to asynchronously interact with each other. The learning process, inspired by the mindful learning theory (Langer, 1997) and other contemporary learning or instructional design theories, encourages learners to take risks and work things out for themselves. All BALOC users are able to upgrade their role within the system by becoming a learner, mentor, author, or a member of the Editorial Board (or to withdraw it) and, thus, actively participate in the learning process.

BALOC has been designed and developed based on Web standards, taking also into account leading learning technology specifications, such as SCORM. Special attention has been paid on the utilization of open source technologies; as such technologies are often of high reliability, and have the best performance and security, perhaps due to the possibility of worldwide review (Wheeler, 2005).

The following section provides an overview of the most known standardization efforts made so far in the learning technology field, focusing especially on ADL SCORM, as it references the most significant e-learning specifications and describes how these can be used together. We also identify, and shortly present, existing SCORM-conformant LCMSs in an attempt to understand their capabilities, and gain an appreciation of their possible weaknesses. Thereafter, the BALOC design characteristics and the

Figure 1. Chapter overview
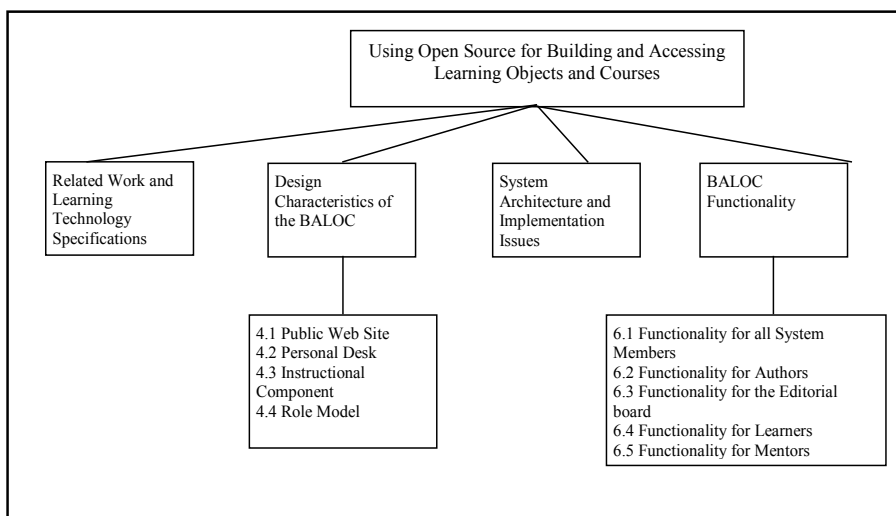
role model adopted to differentiate the rights and the access levels to the provided functionality are presented. Subsequently, we introduce the system architecture, and we discuss issues raised during its implementation. Key characteristics and services BALOC provides to its end users, depending on their role, are also presented. We end up by providing future directions and conclusions.

Related Work and Learning Technology Specifications Overview

In the last few years, a great number of LCMSs have emerged for deploying e-learning. The tools they provide for creating and maintaining learning content and infrastructure applications vary a lot in capabilities and complexity. In order to achieve the obvious benefits of learning content reusability and accessibility in a variety of learning, performance, and knowledge management requirements, organizations, committees, and initiatives from the academic, industrial, and governmental sector put special efforts into developing learning technology standards. The most well known are the efforts made by the IEEE Learning Technology Standardization Committee (LTSC), the ARIADNE Foundation, the CEN/ISSS, the Aviation Industry CBT (computer-based training) Committee (AICC), and the IMS Global Learning Consortium. The Department of Defense of the US government has undertaken the role of the coordinator, and the Advanced Distributed Learning (ADL) initiative it has established has presented a reference model that is known as the "Shareable Content Object Reference Model," or SCORM.

The three main areas of interest of all the standardization efforts concern (Bouras, Nani, & Tsiatsos, 2003; Kaliakatsos, Malamos, & Damianakis, 2002):

- **Metadata:** how a learning resource can be described in a consistent way regardless of a specific learning context or a specific educational purpose. The IEEE LTSC Learning Object Metadata (LOM) is the first accepted standard regarding metadata. It is referenced by the IMS LOM specification as well as the ADL's SCORM. The ADL initiative actually applied the IMS LOM specification to the three components of the content model adopted in SCORM. This "mapping" has been considered as the missing link between general specifications and particular content models.

- **Packaging:** how learning resources, together with information about the intended behavior of the content, can be aggregated into useful packages. Even though, the last few years, a number of content packaging implementations revealed, the IMS Content Packaging Specification seems to be the most

flexible and feasible solution. According to the IMS specification, a content package includes information regarding the metadata of the whole course (using elements form LOM), the structure (for chapters etc.) and the resources (a full list of the files or URLs used) of the course. This specification is also referenced by SCORM.

- **Communication interface or API (application programming interface):** how the learning resources can communicate with external systems. The communication interface refers to the way learning resources can exchange information in run-time with an LMS. The first API has been presented by AICC. However, the current trend is the substitution of the AICC communication protocol by the one presented in SCORM, which actually presents a very fast rate of adoption.

Compatibility with e-learning standards is essential to the future growth and success of an LCMS in education. To that end, many efforts have been made to develop LCMSs for producing multimedia educational material for the Web, compliant with e-learning standards. TotalLCMS, for example, a well-known platform for learning-content management and assembly as well as for personalized learning content delivery, conforms to SCORM and AICC specifications. The same applies for Top-Class LCMS, which is part of the TopClass e-learning suite. Another recognized learning content management system is Learn eXact, which allows for automation and production of different versions of the same learning contents, based on different standards such as SCORM, IMS, and AICC, and commonly used peripheral devices. Xtention Enterprise is another SCORM-compliant LCMS that provides the infrastructure for enterprise training and management needs.

Despite the wide variety of the LCMS currently available, digital learning materials do not yet play the central role that they could in the learning process (Papadakis & Hadzilacos, 2005). Content creation and production of e-learning material has been proved to be a time-consuming and costly process, and questions have been raised about the time and effort required by instructors/authors to generate effective e-learning materials. There is indeed an increasing need for LCMS authoring and assembly components to expose a user interface tailored to the specific task of developing learning content. Furthermore, to make e-learning material really good, a number of users have to participate in its creation, such as authors and didactic workers. These are some of the issues that affect instructors today, and which BA-LOC will have to tackle.

Design Characteristics of a System Targeted at Building and Accessing Learning Objects and Courses through the Web

In this section, we present the design characteristics of the Web-based tool we propose for building and accessing learning objects and online courses. The following scenarios would sound familiar to distance learners and instructors to whom this writing is directed, and would raise some issues associated with the implied developments in BALOC tools and services.

- **Scenario 1: The instruction's view.** Maria is a radio-pharmacy lecturer in Athens University. Due to the lack of teaching courses and teaching material available to the community of radio-pharmacists, she is interested in developing a course on the generation, preparation, and quality control of radiopharmaceutical elements. She discussed this issue with a radio-pharmacy practitioner in London she had worked with a few years earlier, who encouraged her and decided to support her in this task. He also promised that he would try to get in contact with some other practitioners and researchers in Portugal and Belgium, inviting them to participate. These experts could bring in texts, simulations, videos, and other material they had at their disposal.

- **Scenario 2: The students' view.** Tom is a radio-pharmacy student in the U.S. He decided to use distance-learning courseware as a source of scientific information in order to increase his knowledge in the field. He prefers the traditional situation of material being presented as standard lectures from an instructor, favoring written material, graphics, illustrations, and interactive materials. He wants to determine, on his own, the pace and intensity of learning, and get support by an expert only in the cases he really needs one. Furthermore, as he is already working in the field, he does not require a full course.

Based on these usage scenarios, as well as the requirements an up-to-date e-learning system should meet (as they have been presented in the introductory section), and the theories and principles of the mindful learning theory (Langer, 1997) and other contemporary learning or instructional design theories, the functional specifications of the BALOC system have been extracted.

According to them, the system requirements concerning the learning content creation and delivery through the Web can be summarized as the following:

- The system should support the import of a wide variety of file types, with an emphasis on multimedia files.

- The learning resources should be easily merged and aggregated to produce a modular repository of training material.

- The courseware should be divided into small modules, so that it can be used by those not wanting to complete the entire course.

- Learning content should be used and reused within different learning objects and instructional units, thus avoiding content duplication within the system.

- The system should provide online examinations with feedback. Examinations may include multiple-choice, matching, fill-in-the-blanks, and open short-answer questions.

- The learners' interactions with the content should be tracked. On accessing a course, a learner could choose whether his/her interactions with the content will be tracked. These interactions include, among others, the time the learner spends on a learning resource, other related learning resources selected to view, as well as answers on assessment objects.

- Learners should be provided with courses related to the field of interest, which should be accessed on a distance basis through the Web.

- The courseware should be designed to be delivery-platform independent.

- The system should provide mentors with whom the learners can communicate online.

- The design and the technology to be used should not demand any particular computer science or e-learning skills.

These requirements have next been transformed into system functional specifications. BALOC was intended to be an open and user-oriented environment that would facilitate users to take part in it. Therefore, the system was distinguished into three main-components, tree-functional areas: (a) the Public Web Site, (b) the Personal Desk component and (c) the Instructional component.

Public Web Site

The Public Web Site constitutes the introductory system component and it is accessible by all users. Its main aim is to present the system to the wide audience by supplying general information about it, and by encouraging potential system members to take part in or request more information. Users accessing the Public Web Site can be informed of the available courseware as well as the technology exploited to implement the whole system. The Public Web Site also acts as a gate for the already registered users.

Personal Desk

The Personal Desk area addresses users that have been subscribed to the system. In this area, a system member can be informed of all the registered users, and communicate with them via private messages or e-mails. A system member can fill in a card with personal information (personal card), such as his/her username, e-mail address, and interests, and part of this information may be viewed by other system members. In the Personal Desk area, users are also provided with tools that allow them to request, for undertaking or withdrawing, certain roles in the Instructional Component (i.e., the role of a learner, mentor, author, or member of the Editorial Board, as discussed in *Role Model*).

Instructional Component

The Instructional Component consists of the core functional area of BALOC. Its main aim is to support the creation of, and access to, the learning content, and facilitate learners, mentors, authors, and members of the Editorial Board in interacting with each other. The Instructional Component consists of an LCMS integrated with a learning-management element.

The LCMS provides tools and services, and exposes an intuitive user interface that allows authors to easily develop accessible, reusable, and traceable learning objects and courses. In particular, the LCMS, in line with the system functional requirements, provides an authoring tool that enables content authors to:

- Import content of various file types.
- Create learning objects that incorporate one or more of these files, and define how these will look.
- Create assessment objects consisting of a matching, fill-in-the-blanks, open short answer, or multiple-choice question (true/false and multiple answer questions are also included).
- Develop courses that are made up of one or more learning objects and/or courses, define the order in which these are intended to be delivered to the learners, and include them in specific catalogs.
- Describe learning resource using metadata.
- Edit the structure of a course, and
- Edit metadata elements.

Learning content imported or created by means of the LCMS will be stored in the system. Though, only content that has been reviewed and approved by the Editorial Board would be made available while developing new learning objects or courses, or for being delivered to the end-users. In this way, it is assured that learners are delivered with content of high quality. The LCMS is also responsible for monitoring the learners' interactions in terms of their learning activities. This "interaction monitor" tool will extract the details of the interactions from messages sent for the Web pages. Users' actions within a Web page, such as the information about the time that the user spends viewing a page and answers to assessment questions, will be tracked. Such information about the learner will be made available to his/her mentor.

The BALOC learning management element has as main goal to encourage and facilitate the learners' access to pedagogical resources. Before accessing a course, learners would fill in a form with information about their educational and professional background. The pedagogical resources will contain a complete representation of the courseware, the relationships between learning assets both within a page and across pages, conceptual relationships, and recommended answers to self-assessment quizzes. This may be thought of as an expert's view of the courseware. It is this information that mentors will use to analyze the learner's interactions with the system and offer pedagogic advice.

Within the Instructional Component, the Editorial Board, apart from being responsible for reviewing any change in the learning content, will also decide on the assignment of the learner's, mentor's, or author's role to system members wishing to upgrade their role in the system, as well as their expulsion from the Instructional Component.

Role Model

A significant factor that has been taken into account during the BALOC design phase was the definition of the user's roles and the access levels each role involves. Therefore, this subsection is dedicated to the policies that guide the user's interactions within the system (Figure 2).

Within BALOC, the following roles can be distinguished:

- **Visitor:** This role refers to non-registered users. Visitors can only access general information about the system (Public Web Site). They have the ability to register in the system by filling in a registration form.
- **Member:** Members are users that have been registered in the system. These users can be informed of the available courses, though they cannot access

them, as well as to complete and edit, at any time, their profile. They are also able to exchange private messages with other system members.

- **Learner:** This role corresponds to members that have requested the learner's role and filled in a form concerning their educational and professional background. A learner is able to access a course in two modes: browse or study. In browse mode, the learner is delivered with the content of a course in a non-systematic way. he/she is able to jump from topic to topic without his/her interactions being monitored. In study mode, the system "monitors" the learner's interactions within the course.

  A learner is able to choose a mentor that will support him/her in a certain course, and with whom he/she can communicate online though private messages and/or e-mail. He/she can also view information about his/her activities within a course he/she has accessed in study mode. A learner is also able to search and retrieve content of his/her preference.

- **Mentor:** The role of a mentor is assigned to members that wish to upgrade their role in the system, and who have the appropriate educational and professional background (subject experts) to support learners. Users with that role can be mentors for more than one course. A mentor can define the maximum number of learners he/she will support by a) answering questions or b) accessing information about the learners' educational and professional background and their interactions with the content of the course, and advising them appropriately.

- **Author:** Users that have undertaken this role have, as main responsibility, the learning content provision. They can access a course but, as opposite to a learner, their interactions with the content will not be monitored. In order to be monitored, an author should also take on the learner's role.

Figure 2. Role model
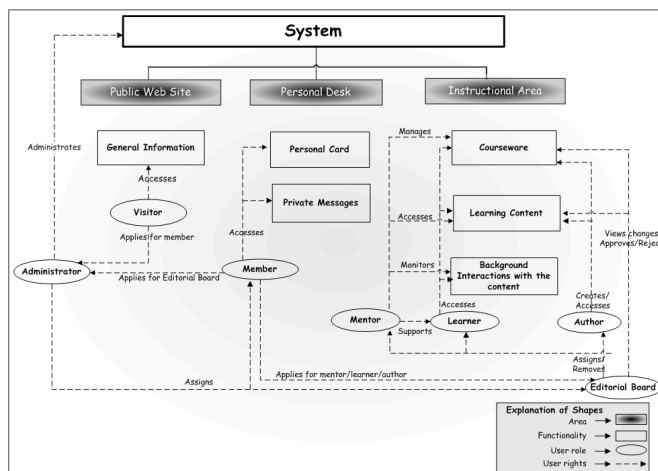
- • **Editorial Board:** The Editorial Board is a special group that (a) decides on the assignment/withdrawal of the learner's, mentor's, author's role to a system member, (b) can remove a system member from the Instructional Component by taking away the member's additional roles, and (c) controls, qualitatively, any change in the learning content, and approves or rejects it accordingly.

- • **Administrator:** This represents a group of users with a technical role having, as main responsibility, to (a) assign/withdraw the role of the Editorial Board to a system member, (b) insert/delete other system administrators to/from the system, (c) insert/delete a member to/from the system, (d) activate new functionality, (e) control the data consistency, and (f) fix possible bugs.

Figure 2 depicts the role model adopted for the purposes of our system.

In conclusion, BALOC adopts a role model that allows any user to upgrade his/her role in the system, by becoming a learner, mentor, author, or a member of the Editorial Board, or to withdraw it. This distribution of the access rights allows for the users' active participation in the learning process.

System Architecture and Implementation Issues

The step that followed the system functional specification was the definition of the computer system that could support all the functional characteristics and services BALOC was envisioned to support to meet its end-users' needs. This system technical specification formed our guide throughout the development process.

Figure 3. System architecture overview
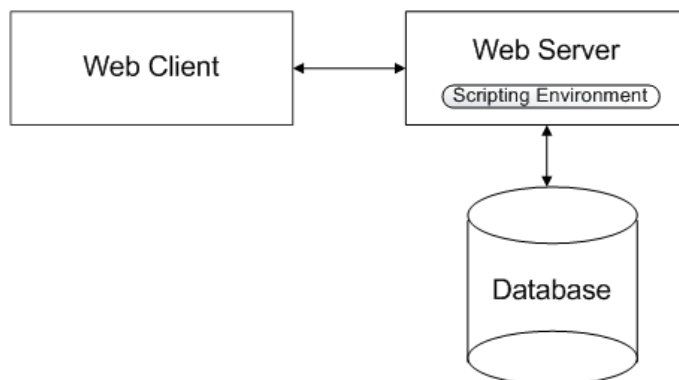
As BALOC was intended to be an easily accessible Web-based learning system, bandwidth and client-side system constraints would be taken into account. The main prerequisites for the system architecture have been a) Minimization of the client-side system requirements, which means that the end users would be able to access BALOC using a typical computer without excessive H/W or S/W requirements; b) Cost minimization of the client-side system set-up, which implies that the client-side software would be free of charge with minimal H/W requirements; c) Cost minimization of the server-side set-up, which means that it would be better to utilize open source technologies, which do not demand excessive H/W requirements; d) The system would run on a variety of platforms, and e) as an e-learning system, it would be based on one or more learning technology specifications.

According to these criteria, the BALOC architecture was founded on certain principles: the system would be platform-independent and based on well-known Web and learning technology standards. The main modules of the BALOC architecture are the client, the Web server together with the scripting environment, and the database (Figure 3).

- The client is the end-user's computer, with an Internet connection and a Web browser. The user utilizes the Web browser to enter the system and exploit the offered functionality.

- The Web server is responsible for storing the learning content, as well as for storing and executing the scripts of the scripting environment. It interacts with the Web browser, through the HTTP protocol and with the database, by means of the scripting environment.

- In actual fact, the scripting environment is one of the basic components of the system architecture. It constitutes the link through which the other system components can communicate with each other, and contributes to the smooth and effective delivery of the appropriate content and values. It supports interaction with the database, system administration, user authentication, manipulation and extraction of the user's role and access rights in the system, but it also supports the Personal Desk and the Instructional Component.

- The database constitutes the core of the whole system, where the majority of the available information is stored and organized. Both the Personal Desk and the Instructional Component need a database in order to operate efficiently. As far as the Personal Desk component is concerned, the database is responsible for the management of information regarding the users, the messages exchanged, the content that corresponds to each functional module, and all the events taking place in this area. In the Instructional Component, the database is in charge of storing, among others, information about the available learning resources and the interrelationships, as well as about the learners' activities.

In order to have a common understanding regarding the pieces of content that are used within BALOC, we need to present, at this point, the content model we have adopted. We distinguish three types of learning-content-model components: "assets," "learning objects," (including assessments) and "courses." These are defined as follows (Bouras et al., 2003b):

- **Assets:** Assets comprise the basic constitutive element of the courseware. They refer to raw media files that can be viewed by a Web browser, such as slides, flash objects, and 3-D simulations.

- **Learning objects/assessments:** A learning object refers to the learning content launched by the learning-management element and delivered to the BALOC end user during a courseware learning experience. It can be either a collection of one or more assets or an assessment object. Assessments may contain a question of at least four types, namely multiple-choice (true-false and multiple answer are also included), matching, fill-in-the-blanks, and open short-answer questions (including short-paragraph questions).

- **Courses:** A course refers to an aggregation of learning objects and/or courses that form a cohesive unit of instruction. Using a course as part of another course, authors can develop courses nested in any depth and thus, apply learning taxonomy hierarchy.

In order to meet the requirements for content accessibility and reusability, all the three content model components would be described using metadata. We have exploited the SCORM's potential towards this need, as it seems to be the leading specification on the learning technology field (Bouras et al., 2003a; Bouras et al., 2003b). SCORM specification maps the metadata elements to its own content model components, "assets," "SCOs," and "content aggregations." These are defined as follows:

- **Assets:** They concern learning content in the most basic form that can be delivered in a Web client. Web pages, images, and text are a few examples of assets.

- **SCOs:** A sharable content object (SCO) is a collection of one or more assets that can be launched by a learning management system (LMS). However, as opposite to an asset, an SCO can communicate with the LMS, thus allowing the LMS to track down the learner's interactions with the content.

- **Content aggregations:** A content aggregation concerns a content structure that can be used to aggregate Web-based learning resources into cohesive instructional units (e.g., chapters and courses), define the structure of this unit, and associate learning taxonomies. The content structure defines the sequence according to which the learning content will be presented to the user.

Table 1. Interrelations between SCORM and BALOC supported content model components

SCORM content model component	BALOC supported content model component
Asset	Asset
SCO	Learning Object
Content Aggregation	Course

As mentioned, a SCORM-conformant LMS can track the learner's interactions with the content by exchanging information with SCOs. These interactions include the majority, but not all the interactions that need to be tracked down in our system (e.g., open short-answer questions). Of course, SCORM supports many more interactions that, however, are considered out of the system scope. Using the SCORM run-time environment for exchanging all the necessary information between the delivered learning content and the learning management element presupposes the extension of the data model proposed by ADL initiative, the implementation of the appropriate (scripting) functions, to be incorporated in a latter stage into the content, as well as the extension of the API to implement the new functionality. Instead, and in an attempt to create an auspicious but still simple Web-based system, we appose our solution to simplify the whole process. The proposed solution takes advantage of both the course structure and the functionality provided by the scripting environment. Above and beyond, in our system, learners would be able to select the mode of learning and thus, chose whether their interactions with the content will be monitored. This option is not supported by SCORM.

In order to apply SCORM-conformant metadata to the content model components supported by BALOC, we assume the interrelations presented in Table 1. For each one of the components, SCORM defines which metadata elements are mandatory, optional, or reserved by the system. Our system supports the entire mandatory and some of the optional metadata elements defined in SCORM. Furthermore, BALOC makes use of two additional elements to identify whether the respective learning resource has been reviewed and approved by the Editorial Board, and whether a metadata record stores a different version of the metadata elements of a particular learning resource.

The way in which authors can aggregate learning resources to create a course has been inspired, but is not identical to that described by IMS content packaging and SCORM specifications, due to simplicity reasons. The structure of a course, and any other information on the relationships among the various learning resources, are

stored in the courseware database. This database is also used to store and organize metadata annotations and information on the learners' actions within a course.

As far as the technological solutions for supporting all of the BALOC components are concerned, these have been adopted on the basis of the prerequisites for the system architecture, as well as the results of technology and standardization survey we have conducted. We have opted for open source technologies not only due to practical reasons (cost minimization), but also due to characteristics certain Web servers, database servers, and scripting languages present, according to our survey, such as high reliability, performance, security, scalability, and configurability. More to the point, open source technologies are well documented, and the code is in use by a community of people around the world that gather around and discuss specific functionality, design, and coding issues. Using open source, we do not need to commit to a certain proprietary software vendor who might decide not to upgrade some software for some old platform (in such a case, we would be forced either to use the old version or switch to another product).

BALOC exploits the potential of the Apache HTTP server1, which is currently the most popular Web server, with over three times the market share of its next-ranked (proprietary) competitor (Wheeler, 2005). Apache is reliable, secure, with good performance; it runs on almost every platform and supports a variety of scripting languages.

For the scripting environment, we have mainly exploited the PHP2, the most popular server-side Web scripting technology on the Internet today, in combination with the client-side scripting language JavaScript3. PHP is cross-platform and extensible. It has excellent connectivity and high performance. JavaScript is also an open scripting language that is supported by all major Web browsers. In order to support the Personal Desk component, the scripting environment has adopted the principles and the clear structure of the PHP-nuke4, an open source and widely adopted content management and portal solution. To facilitate the creation of the learning objects, which are HTML pages that are ultimately delivered to the learners, the scripting environment is used to provide a WYSIWYG ("what-you-see-is-what-you-get") HTML editor. To that end, we have exploited the HTMLArea5 WYSIWYG editor, which has been developed entirely in HTML and JavaScript. Such an editor allows authors to easily and rapidly develop learning objects, without requiring programming skills.

For the database, we have exploited the MySQL6, which is one of the most popular open source databases. MySQL is supported by PHP and many other Web-scripting languages; it can be integrated with the majority of the Web servers (including the Apache), and runs on almost every platform. MySQL is also supported by PHP-Nuke.

BALOC Functionality

This section is dedicated to the presentation of key characteristics and services BALOC provides to its end users, depending on their role. We put emphasis on functionality provided to authors, members of the Editorial Board, mentors, and learners, as these users are actually involved in the learning process.

Functionality for all System Members

All registered users can access the system through the Public Web Site (http://oura-nos.ceid.upatras.gr:8080/baloc/index.php), where they are prompted to provide their username and password. As soon as they are authorized to enter the system, they are granted (or denied) access to certain functional modules exposed by BALOC in the form of a menu (main menu).

System members are granted access to the "Change Role," "Members," and "My Settings" functional modules. The first one allows users to be informed about the roles they can take over (or withdraw), as well as the pending for approval assignments (or withdrawals) they have applied for. The second functional module enables system members to communicate with each other through private messages, whereas the last one allows users to change their personal settings in the system

Functionality for Authors

Learning content authors are, additionally, granted access to the "Courseware" module. This module presents, in a list, all the main online courses a learner can attend within BALOC. These are courses approved by the Editorial Board that, however, are not part of any other course. Authors, though, are able to view all the approved courses, including those used to form a larger instructional unit, by selecting the "View all courses" option (Figure 4).

Authors, in addition to learners, mentors, and the Editorial board, are also able to search and retrieve learning resources (assets, learning objects, or courses) of their preference by supplying indicative keywords or phrases. These keywords/phrases are searched in the metadata elements. The advanced search functionality allows for a more complex inquiry.

An author can import an asset into the system by locating a file in the local disk of his/her computer and filling in a form with its metadata (at least the mandatory).

He is also authorized to develop learning objects. To create a learning object as an asset collection, authors are provided with an LO Editor (that is actually an ex-

Figure 4. Courseware access for authors

tended WYSIWYG editor, as depicted in Figure 5). The editor allows not only for text processing functionality, but also for selecting and importing an asset into the learning object. When the author selects to insert an asset, a list of all the available and approved assets appear in a new pop-up browser window. Authors can insert one asset at a time to the learning object. To create a learning object that is intended to be an assessment, authors are prompted to choose a question type from a drop-down list. The author is provided with a different form for different question types. The assessment can also incorporate an asset (images or graphs) for illustrative purposes. Whether an asset collection or an assessment, the authoring process terminates by filling in a form with the appropriate metadata elements (at least the mandatory). Asset collections are stored as HTML pages into the Web server, whereas questions are stored into the Courseware database.

The Courseware module also enables authors to create courses. When an author selects to create a course, a new browser window appears on the user's computer screen (Figure 6). The new Web page presents the structure of "on the stocks" course, a list of all the approved learning objects (assessments and asset collections), and a list of all the approved courses. Authors can select, piece by piece, the learning resources that will be inserted in the course, and define the order in which they will be presented to the learners. When the course is finalized, authors need to describe the new learning resource by means of metadata. The structure of the course is stored in the Courseware database.

Figure 5. Editor for creating learning objects as asset collections – LO Editor
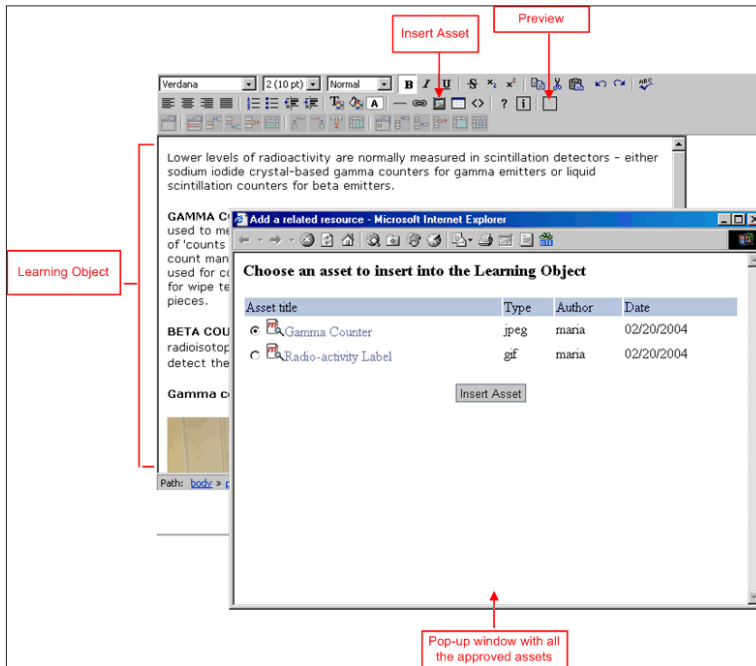
 The structure of a course that has been approved by the Editorial Board can be edited at any time by authors. In particular, as soon as an author accesses the Courseware's main page, an "Edit Structure" button appears next to the title of each course (see Figure 4). By clicking on it, a new browser window opens, as in the case of the course creation. In this case, however, the left part of the window presents the title and the current structure of the course.

Authors are also able to view and edit the metadata of any learning recourse approved by the Editorial Board. These changes need to be approved by the Editorial Board before made available to the rest of the users.

Functionality for the Editorial Board

The members of the Editorial Board are the only users granted access TO the "Editorial Board" functional module. This module informs the authorized users about the pending for approval roles, the pending for approval changes in the learning content, as well as about the members assigned the role of learner, mentor, or author.
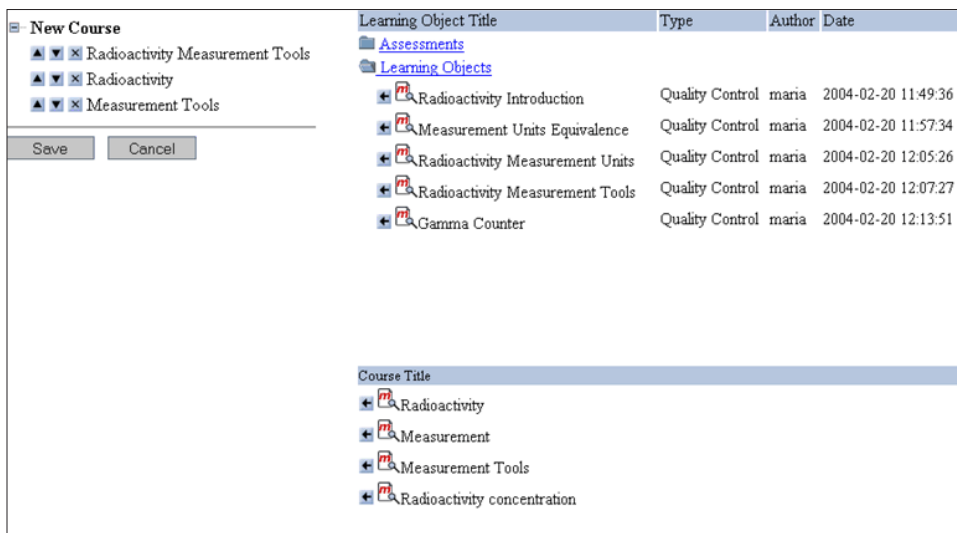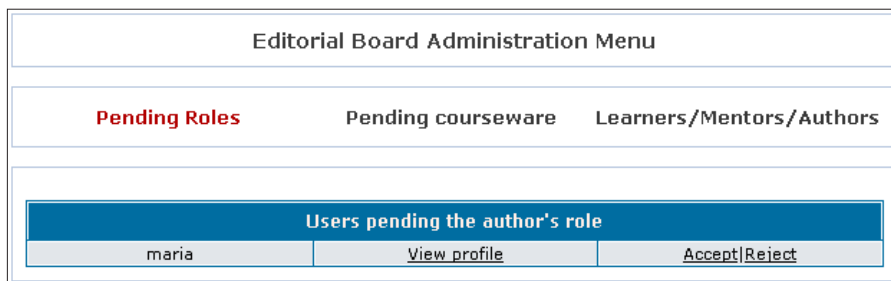
Figure 6. Create course

Figure 7. List of the members that have requested the assignment of the author's role

Let us consider the case that there are pending requests for the assignment of the author's role to certain users. Any member of the Editorial Board can be informed about the appliers, access their profile (Figure 7), and reject or approve their request, accordingly.

The members of the Editorial Board can also be aware of any change in the courseware material. In the case, for example, that a member of the Editorial Board selects to view the recently imported assets, he/she can view and review their actual content and metadata elements, and then decide on their approval. Approved assets are readily available to authors, mentors, and learners, whereas rejected assets are deleted from the Web server, and their metadata is deleted from the Courseware database.

A member of the Editorial Board is, additionally, able to access information about all the system members assigned to learner, mentor, or author role. He/she can also expel a user from the Instructional Component.

Functionality for Learners

Learners, in addition to "Change Role," "Members," and "My Settings" functional modules, are also granted access to the "Courseware" and "Learner Info" functional modules. To become a learner, a system member should firstly apply for the learner's role, and then fill in a form with information about his/her educational and professional background (the form is available at the "Learner Info" area).

Within "Courseware," learners can view a list of all the available courses, which they can access in study or browse mode. Regardless the mode of learning, the learner is delivered with the content of the course (that is presented in a new Web page), as depicted in Figure 8.

The table of contents of the selected course has the form of a hyperlink tree. The color code adopted in the hyperlink tree informs the end user about the learning object he/she is currently viewing, the visited, and the non-visited learning objects. In

Figure 8. Course access example

Figure 9. Information on the learning objects the learner has visited

front of each learning object's title an icon appears to denote whether the particular learning object is an asset collection or an assessment.

Learners can navigate within the course using the "Previous" and "Next" navigations buttons, or by selecting a topic from the table of contents. The option "Contact my mentor" allows a learner either to select a mentor to support him/her in this particular course and/or send his/her mentor a private message.

At the bottom-right part of the page, all the resources related to the learning object that the user is currently viewing are listed. For each one of them, the kind of the relationship is presented. If the related resource is part of the current course, then, by clicking on its title, the learner is delivered with its content. Otherwise, the learner is delivered with the content of the course that contains the related resource.

Through the "Learner Info" area, a learner is able to consult, at any time, statistics about his/her interactions with the content of any course he/she has accessed in study mode. Statistics concern the total time the learner has spent on a course, the number of the different learning objects he/she has visited, and the number of the questions he/she has answered. The learner can also be informed of the related resources he/she had moved into from within this course.

Let us consider the case that a learner wants to view more information about the learning objects he/she has visited. He/she is provided with a page, similar to that depicted in Figure 9, where information about the last time visited and total time spent on each learning object is presented. By clicking on a learning object's title,

the learner can view its actual content. Additionally, the learner can be informed of the learning objects that fall short to complete the course.

In addition, learners are able to access information about the assessment questions they have answered, such as the question's type, the first provided answer, and a history of all the answers he/she has provided from time to time.

Functionality for Mentors

Mentors are the only users granted access to the "Mentor" functional module, through which they can manage courses and learners per course. Mentors are, obviously, able to access all the available courses, though only in browse mode (this is also the case for authors and members of the Editorial Board). This means that their interactions within a course will not be monitored unless they are taken on the role of a learner. A mentor is able to become a mentor in any available course.

At the "Manage Courses" area (Figure 10), the first block presents to a mentor an overview of all the courses he/she is responsible for. For each certain course, the number of the learners he/she has been assigned to support (the number is, actually, a link to the list of the respective learners), the maximum number of the learners allowed (this number can be changed at any moment), and an option to remove

Figure 10. Course management for mentors

Mentor's Administration Menu

Manage Courses		Manage Learners

You are a mentor in

Radioactivity	Currently the are 1 learners assigned maximum number of learners alowed: [2] Save	Remove me as mentor for this course: Remove
Measurement	Currently the are no learners assigned maximum number of learners alowed: [10] Save	Remove me as mentor for this course: Remove
Measurement Tools	Currently the are no learners assigned maximum number of learners alowed: [10] Save	Remove me as mentor for this course: Remove
Radioactivity concentration	Currently the are 2 learners assigned maximum number of learners alowed: [10] Save	Remove me as mentor for this course: Remove

Become a mentor for

You are a mentor for all available courses!

View main courses

himself/herself as mentor of the course are presented. The second block presents the courses the user can become a mentor for.

The "Manage Learners" area provides a mentor with a list of all the learners he/she has been assigned to support within a certain course. Mentors are able to access, at any time, information about the listed learners' activities within the course (provided that the course has been accessed in study mode), as well as information about the learners' educational and professional background. Based on these, he/she can contact a learner in order to advise him/her.

Future Directions

BALOC, at this moment in time, provides tools and services tailored to the development and delivery of accessible, reusable, and traceable learning objects and online courses through the Web. Despite the fact that it presents a series of the features all up-to-date e-learning platforms are expected to expose, new functionalities could be added to allow for more flexibility.

It is in our plan, in particular, to extend BALOC to support the replacement of existing assets and the editing of existing learning objects. These, of course, presuppose the implementation of a version control function. All of these services, in combination with the already provided "Edit Course" facility, would allow authors to keep the content constantly update, without having to develop it from scratch.

The authoring capabilities of the proposed system can also be extended to allow the creation of additional types of assessment objects. In this case, though, we should examine how the users' answers could be tracked. The research, design, and implementation of the way in which new user interactions with the content could be monitored are actually in our future plans. Examples of these interactions are a) the time a user spends on an assessment object until he/she provides an answer and b) the alternative content type the user selects to view (e.g., text or video). This information could provide useful information about the learning content usage and efficacy, as well as the user preferences.

Furthermore, in its present form, BALOC allows users to communicate with each other via private messages or e-mail. In a next step, users would explore new ways of communication, asynchronous or synchronous, that could give them the feeling that they are members of a virtual community. Communication can be one-to-one or one-to-many. Forums and text chat are few examples of the communication services that could be exploited.

Additionally, the integration of a learner modeling system could add a significant value to the provided functionality. A learner modeling system should facilitate the

interactions among the users, but mainly, the user's interactions with the system. By monitoring and analyzing the user's actions, the system could help them with the system use, provide them with pedagogical advice, and encourage them to communicate with each other.

Our future plans also include the design and implementation of a functionality that will allow authors to export courses created in our system in the form of a SCORM-conformant zip file (package). In this way, content created in our system would be imported in any SCORM-compliant system and thus, be available to a wider audience.

All the new BALOC services will be implemented using open source technologies and tools. This is in line with the arguments outlined earlier, in which we do not want to commit to a certain proprietary software vendor, but instead, use reliable, rich-featured and well-supported free software tools. Above and beyond, it is our intention to distribute BALOC code under a free software license.

After the completion of the aforementioned tasks, assiduous evaluation of the system contribution to the learning process could take place. This presupposes the systematic test of the provided functionality by the potential end users.

Conclusion

The Web-based tool presented in this chapter incorporates many of the design characteristics an up-to-date e-learning platform should expose. In particular, as far as the technological approach is concerned:

- A user can access the system through a standard Web browser without the need to install additional software to his/her system.
- The system can run on a wide variety of platforms.
- The system adopts the metadata elements (all the mandatory and the majority of the optional) that are described in SCORM. The adopted content model is also inspired by SCORM. Its clear structure, in combination with the metadata elements, facilitates the easy reuse of the various learning resources for the creation of larger instructional units. Moreover, metadata facilitates the easy search and retrieval of the learning content.

As far as the pedagogical approach is concerned:

- The system encourages and accepts the user's autonomy and initiative. Learners are able to communicate with their mentors in order to get support, as well as with the other system members. Moreover, all registered users can take part in the learning process though one or more different roles. This distribution of the rights and access levels the role model implies encourages the active participation of all the involved users in the learning process.
- For each action, the system provides the user with continuous feedback. For instance, when a user answers a self-assessment, the system informs him/her immediately about a) whether his/her answer was right, and b) which is the indicative answer on this particular question.

In addition, the system offers the following services:

- Services for including and updating user profiles.
- Services for creating courses and cataloguing them.
- Services for creating tests.
- User tracking services.
- Services for creating, organizing, and managing learning content.
- Asynchronous communication tools, such as the private messages functionality.

What is more, learners are able to choose between two modes of learning: browse and study mode. The only difference between these two modes of learning is that only in the latter case, the learner's interactions with the content are monitored. Thus, a learner can go back to the content of a course, at any moment, to review it without his/her actions being tracked.

Within BALOC, every change on the learning material is not readily available to the rest of the users unless approved by the Editorial Board. In this way, it is assured that only learning content of high quality is delivered to the learners.

Last but not least, BALOC is based on open source technologies. Open source technologies are available free of charge, they do not depend on particular companies, they are usually reliable, and they have good quality (due to their qualitative control by many people and the primary evolution of the source code).

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Endnotes

[1]   Apache HTTP Server Project, http://httpd.apache.org

[2]   PHP, http://www.php.net

[3]   The JavaScript Source, http://javascript.internet.com

[4]   PHP-Nuke –Open Source Professional Portal System, http://phpnuke.org

[5]   htmlArea - Turn any <textarea> into a WYSIWYG editor, http://www.inter-activetools.com/products/htmlarea/

[6]   MySQL, http://www.mysql.com

Appendix I: Internet Session: Comparing open source Course Management Systems aimed at the Higher Education Market

http://www.e-learningcentre.co.uk

The e-Learning Centre provides e-learning advice and consultancy to businesses and education. In this Web site, you can find a large collection of links to e-learning resources in the Information section, which is accessible to all.

Interaction

Go to the "Products & Services" Web section. There you can find links to e-learning products and services in the following categories:

1.   e-learning tools and systems
2.   Off-the-shelf e-learning content
3.   e-learning service providers

Click on the "Open source educational CMS/VLEs" link that falls into the first category. There you can find links to open source course management systems aimed at the higher education market, together with their short descriptions. After reviewing the information presented in the respective Web sites, prepare a brief presentation comparing these products.

Appendix II: Case Study: An E- Learning Platform for a Geographically Dispread Community of Professionals

You, as an IT expert, have been assigned to provide an e-learning solution targeted at a community of professionals in a highly specialized field and spread all over the world. Those professionals, in an attempt to overcome the problem of isolation and share knowledge with each other, decided to try an e-learning platform. As the majority of them do not have particular computer technology skills, they just want to use an e-learning platform that will enable them to easily create, publish, and access learning material that is as close to on-the-job training as possible. They also want to communicate and collaborate with each other in order to share knowledge, experiences, and best practices.

Questions

1. What do you see as the critical issues to address in establishing a learning platform for those professionals?
2. How would you proceed in creating the e-learning platform?
3. Assuming that you have the resources to design and develop a state-of-the-art e-learning platform to support the real community of professionals, what would be your design and technological choices?

Appendix III: Useful URLs

IEEE Learning Technology Standards Committee (LTSC):

http://ltsc.ieee.org

ARIADNE Foundation for the European Knowledge Pool:

http://www.ariadne-eu.org

CEN/ISSS (European Commission for Standardisation/Infrmation Society Standardisation System) Learning Technologies Workshop (WS/LT):

http://www.cenorm.be/cenorm/businessdomains/businessdomains/informationsocietystandardizationsystem/elearning/learning+technologies+workshop/index.asp

Aviation Industry CBT Comittee:

http://www.aicc.org

IMS Global Learning Consortium, Inc:

http://www.imsproject.org

Advanced Distributed Learning (ADL) Initiative:

http://www.adlnet.org

e-Learning Center:

http://www.e-learningcentre.co.uk

Content-Management Opportunities:

http://www.gii.co.jp/english/cs10068_content_management.html

Learning Object Metadata use survey: sticking the short and wide in the long and thin:

http://www.cetis.ac.uk/content2/20041015015543

eLearning results:

http://www.elearningresults.com

Dept. Computerwetenschappen, Katholieke Universiteit LeuvenResearch unit on hypermedia and databases, Bibliography:

http://ariadne.cs.kuleuven.ac.be/hmdb/jsp/Wiki?Publications

eLearn: In Depth Tutorials, The Basics of E-Learning: An Excerpt from Handbook of Human Factors in Web Design:

http://www.elearnmag.org/subpage.cfm?section=tutorials&article=20-1

Open Source Resources => Project Hosts, Repositories and Directories:

http://opensource.ucc.ie/projects.html

Technology-Enabled Teaching/eLearning Dialogue, Will Open Source Software Unlock the Potential of eLearning?:

http://www.campus-technology.com/news_article.asp?id=10299&typeid=155

Apendix IV: For Further Reading

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Appendix V: Possible Titles for Papers/Essays

- The Use Of Open Source Technologies to Provide Effective and Efficient Learning
- An Effective E-learning Platform for a Geographically Dispread Community of Professionals
- A Comparison of Open Source E-leaning Platforms