OWLearn: An open source e-learning platform supporting adaptivity and personalization

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Abstract. This paper, based on an analysis of current research and relevant implementations proposes the implementation of OWLearn an adaptive and personalized e-Learning system developed with open source technologies. Adaptation and personalization received very little coverage in the most commonly used e-learning platforms. An e-learning course in these systems is usually designed without matching students’ and teachers’ needs and objectives as closely as possible, and without adapting during course progression. The proposed open source e-learning system offers profiling and personalization services for the teacher and student while at the same time adapts the educational content and tools in the basis of the acquired user’s profile. Finally, the proposed system offers collaborative learning using social networking services and mobile learning tools for achieving ubiquitous life long learning.

Keywords: E-learning system, adaptivity, personalization, open source software, social networking, mobile-learning

1. Introduction

The majority of current e-Learning courses are mainly based on Learning Management Systems (LMS) that support a great variety of activities performed by teachers and students during the e-learning process. A traditional LMS offers to all its users the same services and content, meaning that all learners taking an LMS-based course, regardless of their knowledge, goals, and interests, receive access to the same educational material and the same set of tools, with no further personalized support. Adaptation and personalization received very little coverage in these commonly used e-learning platforms. An e-learning course should be designed towards matching students’ and teachers’ needs and desires as closely as possible, and adapting during course progression. Personalization and adaptivity features are considered necessary for the production of innovative e-Learning 2.0 systems differentiating from, the mostly used until now, static e-Learning systems.

On the other hand, Adaptive E-Learning Systems (AES), is a recognized class of adaptive web systems which attempt to a personalized approach to E-Learning. Profiling, content adaptation and annotation, collaborative learning are features provided by a modern AES. Nevertheless, the Adaptive Learning Systems are too focused on performing specialized functions (e.g. content annotation) and lack on overall integration and as a consequence re-use of content and services. The solution proposed is to combine the advantages of both LMS (integration, re-use and an adequate set of services for both learners and teachers served by one system) and AES (adaptivity and personalization). This solution will be implemented by extending the capabilities of a traditional open source LMS by adding adaptability and personalization issues.
This paper reviews at first the traditional Learning Management Systems and existing Adaptive E-Learning Systems. Secondly, the available open source e-learning platforms are being evaluated mainly studying if and in what depth adaptivity and personalization features are supported by these systems. Following this paper reviews and defines the functional requirements of an adaptive and personalized e-learning system and its basic architectural components. Combining the results of the aforementioned reviews a new open source e-Learning platform is being proposed, OWLearn, offering profiling and personalization services for the teacher and student while at the same time adapts the educational content and tools in the basis of the user’s profile. In addition, the system supports social networking services and tools for mobile e-Learning.

2. Review and analysis of current research

This section compares the traditional Learning Management Systems and existing Adaptive E-Learning Systems in terms of services offered, advanced features and main characteristics.

Current E-Learning is mainly based on the Learning Management Systems (LMS) [3] which can be divided to close corporate systems such as the Blackboard (Blackboard) and WebCT (WebCT) and to open source systems like the Moodle (Moodle) and ATutor (ATutor). In both cases, these learning management systems (LMS) are integrated systems that support a great variety of activities performed by teachers and students during the e-learning process. In most of cases, teachers use an LMS to develop Web-based course notes and course material, to communicate with students and to monitor and grade student progress. On the other hand, students use it for learning, communication and collaboration. As is the case for a number of other classes of modern web based systems, LMS offer their users seamless services and content, meaning that all learners taking an LMS-based course, regardless of their knowledge, goals, and interests, receive access to the same educational material and the same set of tools, with no further personalized support.

Adaptive E-Learning Systems (AES), on the other hand is a recognized class of adaptive web systems [4] which attempt to a personalized approach to E-Learning. Current research on adaptive E-Learning demonstrate that for every function that a typical LMS can support every aspect of web-enhanced education better than LMS, each particular system can typically support only one of these functions. For example, SIETTE [14] comprehensively supports the most important portions of a typical Lisp course – from concept presentation to program debugging. Yet, almost 10 years after the appearance of the first adaptive Web-based educational systems, just a handful of these systems are actually being used for teaching real courses, typically in a class lead by one of the authors of the adaptive system.

Nevertheless, The problem of the current generation of AES is not their performance, but their architecture. Structurally, modern AES do not address the needs of both university teachers and administration. The first issue is the lack of integration. While AES as a class can support every aspect of web-enhanced education better than LMS, each particular system can typically support only one of these functions. For example, SIETTE [14] is only a great system for serving quizzes, but it can’t do anything else. To cover all needs of web-enhanced education with AES, a teacher would need to use a range of different AES together. This is clearly a problem for the university administration that is responsible to maintain and provide training for all these systems. It is also a burden for the teacher who needs to master them all and for the student who needs to manipulate several systems and interfaces – all with separate logins – and all at the same time. E-Learning stakeholders have a clear need for a single-entrance, integrated system that can support all critical functions in one package. LMS producers have recognized this need several years ago. Just in a few years after their emergence, LMS have progressed from one-or-two function systems into Web-based information
systems that can cover all needs. The second issue is the lack of re-use support. Modern AES are self-contained systems and can’t be used as components. A teacher who is interested in re-using some content contained systems and can’t be used as components. The second issue with its specification – to accept all or none of an intact system, for example, several ELM-ART Lisp problems) has only one choice – to accept all or none of an intact system, with its specific way of teaching, thereby sacrificing his or her preferred way of teaching the course. Once one excludes the authors of existing adaptive systems who built those systems to support their way of teaching, it is rare that one finds a teacher who is willing to do that. In contrast, LMS have always supported teachers in developing their course material from various components. Modern courseware-reusability frameworks such as ARIADNE [19] extend this power by providing repositories of reusable educational objects.

The key issue is how to combine the advantages of modern AES, such as adaptability and personalization with the key features of traditional LMS which are integration, re-use and an adequate set of services for both learners and teachers served by one system). Towards this objective, the available open source e-learning platforms are being evaluated mainly studying if and in what depth adaptivity and personalization features are supported by these systems. This paper also, reviews and defines at first the functional requirements of an adaptive and personalized e-learning system. Following, based on the results of the aforementioned studies, a new open source e-Learning platform is being proposed offering profiling and personalization services for the teacher and student while at the same time adapts educational content and tools according to the user’s profile.

3. Adaptation and personalization as anticipated in existing open source e-learning platforms

This section proves that existing open source e-Learning systems may support, under certain circumstances adaptation and personalization features but need extension and elaboration to acquire these characteristics. This statement is based on an evaluation of open source e-Learning platforms conducted by Sabine G. et al. [15].

The main focus of the evaluation conducted by Sabine G. et al. was on adaptation and personalization capabilities and features of these systems. Regarding the so-far e-Learning systems, adaptation received very little coverage in e-learning platforms. An e-learning course should not be designed in a vacuum; rather, it should match students’ needs and desires as closely as possible, and adapt during course progression. An evaluation of open source e-learning platforms with the aim of finding the platform most suitable for extending to an adaptive one was therefore very crucial and important. The extended platform could be utilized afterward in an operational teaching environment. Therefore, the overall functionality of the platform is as important as the adaptation capabilities, and the evaluation treats both issues.

According to the study of Sabine G. et al. [15], after a pre-evaluation phase, nine open source platforms for e-Learning were analyzed in detail. The platforms were namely Moodle, ATutor, Dokeos (Dokeos), dotLRN (dotLRN), ILIAS (Ilias), LON-CAPA (Lon-Capa), OpenUSS (OpenUSS), Sakai (Sakai) and Spaghettilearning (Spaghettilearning). Based on the same study [15] Moodle dominates the evaluation by achieving the best value five times. The strengths of Moodle are the realization of communication tools, and the creation and administration of learning objects. Additional strengths of Moodle are the comprehensive didactic concepts and also the tracking of data. Furthermore, the outstanding usability of Moodle leads to the maximum evaluation value in the usability category. Concerning the other platforms, ILIAS obtained the best values in the categories technical aspects, administration, and course management. According to Sabine G. et al. [15] Moodle achieved the best evaluation values. Also the second and third rank can be assigned clearly to ILIAS and Dokeos. According to the pairwise comparisons ATutor, LON-CAPA, Spaghettilearning, and Open-USS are ranked equally at the fourth position, whereas Sakai and dotLRN are ranked last. The reason for the low ranking of Sakai is that so far only the basic features are realized. But, the quality of these features is very good.

Consequently, Moodle obtained the best results in general as well as in the specific adaptation evaluation criterion. So an extension of the selected platform in a way that the courses adapt to the unique strengths, learning objectives, knowledge levels, and learning styles of each individual learner is feasible. The functional requirements and the architecture of the OWLearn, an adaptive, personalized and open source e-Learning system, based on the Moodle platform, are presented in the next section. In addition, extra social networking services for the learners and mobile e-Learning tools are being incorporated so as to achieve life long learning everywhere and anytime.
4. OWLearn – Functions, services and architecture

The proposed architecture is transforming a traditional teacher-centric and course-centric learning environment, in which the “knowledge push” axiom is dominant, to a learner-centric and interest-based learning environment which encourages “knowledge pull”. This Section is presenting the adaptive and personalized open source e-Learning system, its functional requirements and initial architecture.

The system is based on international technological standards for open, synchronous and asynchronous learning (Open Learning Space) and for social networking. These technological standards and good practices are focusing on collaborative learning and self – directed personalization. They are mainly based on and take advantage of Web 2.0 technologies, social software and social networking techniques which support user participation during the interaction and production of the educational content.

Specifically, the proposed learning environment will support both asynchronous as well as synchronous learning via a usable and adjustable user interface. The first step is extending Moodle open source learning platform. Moodle is mainly used for structured educational content providing. Moodle will be upgraded to a platform supporting collaborative learning (formal and informal), collaboration through structured discussion, the efficient use and re-use of the educational material the creation and management of virtual working spaces and advanced search capabilities. In addition the platform will include knowledge discovery and content annotation features for all user and media types and will support live streaming for seminars and conferences. The new upgraded system will serve as a platform also for personal and social learning.

Except for the traditional characteristics of a Course Management System, the system will provide user-centered and personalized learning based on the individual profiles, learning styles and user preferences. The user will have the ability to control and adjust the learning process in accordance with his/her interests. As a result the platform will not only support advanced personalization but will also combine features of Web 2.0 and social networks technologies. Specifically, the OWLearn will support:

- Personalization in accordance with user needs, user learning models and user preferences.
- Profiling using on-line forms for acquiring user information and a profiling system for defining the user’s learning style.
- Creation and management of virtual working spaces emphasizing on concept and visual mapping and conceptual representations.
- Social networking capabilities.
  - Informal collaborative learning using facebook like e-Learning processes.
  - Collaboration support through structured discussions.
  - Blogs and microblogging (mini blogging capabilities).
  - Wiki-like personal and group webpages.
  - Creation of discussion groups.
  - Social bookmarking, providing a method is for the users to organize, store, manage and search for bookmarks of educational resources online. The bookmarks are being shared between the platform’s users.
  - Content tagging especially for text, audio and video.
  - Knowledge mining features for efficient re-use of educational resources.
  - Podcasting media files from the e-Learning system to the users.
  - RSS feeds for news and announces.

In parallel, synchronous e-Learning will be supported within the framework of the proposed platform. The services for synchronous e-Learning will include capabilities for Webinars creation with streaming video, web conference applications and web broadcasting for the creation of seminars, events and workshops. The synchronous e-Learning services will also include:

- Two-way streaming for audio and video.
- Virtual class facilities.
- Answering questionnaires, multiple choice and Boolean questions during a session.
- On-line chat.
- Polls and forums.
- Electronic whiteboard.
- Video and audio recording capabilities.

Both services for asynchronous and synchronous e-Learning will be integrated in a seamless and homogenous user environment. The learning objects will be created based on international technological standards, such as Sharable Content Object Reference Model (SCORM 1.2) and will embody video conferences, interactive presentations and multimedia enriched educational content.

The architectural modules are being presented in the next figure:
4.1. Moodle core

Moodle is an Open Source Course Management System (CMS), also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). It has become very popular among educators around the world as a tool for creating online dynamic web sites for their students. To work, it needs to be installed on a web server somewhere, either on one of your own computers or one at a web hosting company. In addition, the Moodle is adequately open so as a developer to add new features and capabilities. The Moodle Core for the OWLearn is a standard Moodle installation for developers which serves as a platform for implementing the required expansions so as adaptivity, personalization, social networking and mobile e-Learning to be achieved. The installation includes the database, enabling the servers for open source programming languages and running the basic e-Learning services such as user management, course management, course serving etc.

4.2. Personalization tools

The personalization tools are mainly aiming at collecting the user’s individual profile and personalize the interfaces according to user preferences. In addition, the personalization tools gather useful data so as the educational content to be adapted based on user experience, previous knowledge and academic performance. The basic design principles concerning personalization in the OWLearn system is to construct tools which have the ability to a) gather the basic information about the user and b) categorize users based on their learning style c) tracking the academic performance.

The personalization tools offer brief on-line questionnaires from which basic information and the learning style of each individual is extracted. The learning styles supported include Visual Learners, Auditory Learners, Tactile/Kinesthetic Learners etc. The tools also gather information about most viewed courses, grades, quiz results for each user and create a pool of information for tracking academic performance. This data is a solid basis for adapting the content to each user preferences and experience. The personalization tools are under development.

4.3. Adaptivity

Adaptivity features are crucial for achieving modern e-Learning 2.0 education. An e-learning course should be designed towards matching students’ and teachers’ needs and desires as closely as possible, and adapting during course progression. Adaptivity is considered necessary for the production of innovative e-Learning 2.0 systems differentiating from, the mostly used until now, static e-Learning systems.

Three important steps are taken so as adaptivity to be achieved.

1. Content tagging especially for text, audio and video. The content uploaded by the teacher is tagged and accompanied by necessary metadata so as to be suitable for various cases of students concerning their learning styles, experience and academic scores.

2. Knowledge mining features for efficient re-use of educational resources. In addition to content tagging, knowledge mining features are included so as to support advanced searchers from students and teachers. A strong knowledge mining engine will assist content re-use and adaptation.
3. Adaptive content delivery. Content delivery on demand and based on user preferences and experience.

The adaptivity features of the OWLearn platform are under development.

4.4. Social networking – Extending to Web 2.0 capabilities

The focus of this module is how e-Learning and Social Networking could be brought together aiming at aligning OWLearn to the principle of Personal Learning Networks (PLN). The key solution is to incorporate Web 2.0 services to the existing platform’s interface extending at the same time its core capabilities.

The first step to implement the social networking feature for OWLearn is to expand the user profile page, adding user tags so as to describe interests etc, as links to “interest pages, e.g. constructivism”. The interest pages contain information about all the people who share that interest, as well as blog entries that use that tag, google searches, other info using standard Moodle blocks etc. Based on these common interest pages the users are allowed to add other users as “friends”, which are displayed on their user profile pages. These tags will enable users of the OWLearn to describe and share their interests in a systematic way, increasing the potential for interactions among them. Tags will enable users with a certain interest to be found more easily. They will also make it easier for users to find documents, presentations, forum topics and blog entries related to a subject.

A scenario of using this advanced user profile is searching for people with a given interest. Suppose, for example, that a PhD student from the computer science department writing a paper about computer graphics algorithms for diagnosis of heart diseases. It would helpful to get some feedback on the paper from someone whose research specialty is Cardiac Tomography or Heart Disease Diagnosis. Knowing that the student’s Medical Research department uses OWLearn intensely for their courses, the student visits a “Search tags” where he tries a query on “Cardiac Tomography” in the search input field. Since this tag (Cardiac Tomography) is non-existent in the system, the student gets a result of a list of close matches: cardiac surgery, cardiac diseases, computed tomography. The student selects the cardiac diseases tag and he gets redirected to a page which contains all entities in the system (Users, Blog entries, Forum topics and Files) labeled with this tag.

The search results in 4 related tags for example present, 20 members that have interest in cardiac diseases, 9 files, 5 blog entries and some forum topics. The student selects a member and adds him as a friend by looking at his interests.

Each student – member have a personal wiki-like web presence within the OWLearn’s space where the personal interests will be included plus services for sharing information content. These services include:

- Shared bookmarks. Social bookmarking within the platform’s space.
- Shared galleries. Sharing digital content with educational purposes.
- Content tagging facilities for the digital content uploaded by the students – members.

The features are enriched with extra social networking services, such as:

- Collaboration support through structured discussions.
- Blogs and microblogging (mini blogging capabilities).
- Creation of discussion groups.

In the next figure an example of a students personal space is being presented.

4.5. Mobile e-Learning – Learning everywhere and anytime

The OWLearn architecture includes also a module for Mobile e-Learning. This is considered crucial so as the objectives of ubiquitous e-Learning to be fulfilled. A specialized user interface which includes e-Learning services for mobile phones and especially for i-phones has been designed and is under implementation. Creating learning courses for mobile devices and i-phones raise specific technical and functional requirements, which are summarized in the next important points:

- Limit Graphical Content. With the tight mobile device screen being roughly a twelfth (or smaller) of a desktop screen, large-screen graphics not only increase load times, but also take up valuable space that is needed to display text, hyperlinks, and other important information.
- Text Considerations Text should be limited – briefer is better. Layout should be structured to avoid the need for scrolling. Thus, this involves breaking up text into smaller pieces/sections and linking to those smaller pieces, instead of putting a lot of text on one screen. Smaller fonts are also
recommended. For example, Microsoft Windows Mobile standard is Tahoma with a point size of eight, which is an appropriate size for text viewed in the Apple iPhone’s Safari Web Browser.

- Limit Use of Data Entry Since the keyboard is a limited size, input fields should be kept to a minimum to reduce the amount of typing. Where possible, provide possible text or phrases to avoid needing the user having to type. These text items should have a hyper-link associated with them to serve as an easy way for users to select them, rather than having to type them on the keyboard.

- Utilize Empty Space Another design guideline is to utilize screen space. Avoid excessive horizontal and vertical spacing between screen elements. Unlike designing a print ad or brochure, you don’t need a lot of “white space” on mobile device’s screen.

- Place Non-Essential Links at the Bottom of the Screen Hypertext links that are not relevant to the information being displayed should be placed at the bottom of the page to preserve space. This places critical information in the user’s view upon entry to the screen or page. For example, a navigation menu that would normally be on the left or top of the screen of a desktop computer should be placed at the bottom of the screen for a mobile device.

Based on the above criteria the educational content imported into the OWLearn platform fulfill the technical specifications for images, text, audio and video. The teacher inserts content both for the web user interface and the mobile interface. A snapshot of the under development Mobile e-Learning system follows.

5. Future work

The future work focuses on the implementation progress, deployment and evaluation. Towards these goals the OWLearn infrastructure is being reinforced and extended so as to have adaptation and personalization features. These extensions are mainly created with scripting and object oriented programming languages and are further added as modules to the Moodle core. These new modules are focusing at this phase on acquiring the user profiles via on-line forms and advanced login facilities, on producing the user model and on adapting the content delivered to the user based on the specific user model.

6. Conclusion and results

This paper reviewed at first the traditional Learning Management Systems and existing Adaptive E-Learning Systems. The conclusion of this review is that a combination of the advantages of modern AES, such as adaptability and personalization with the key features of traditional LMS which are integration, reuse and an adequate set of services for both learners
and teachers served by one system is necessary so as an efficient and open learning platform to be developed. To fulfill this combination the proposed solution is to select an open source traditional LMS and upgrade its capabilities focusing on adaptation and personalization. Towards this goal, the available open source e-learning platforms were evaluated mainly studying if and in what depth adaptivity and personalization features are supported by these systems. Moodle obtained the best results in general as well as in the specific adaptation evaluation criterion. So an extension of the selected platform in a way that the courses adapt to the unique strengths, learning objectives, knowledge levels, and learning styles of each individual learner is feasible. Combining the results of the aforementioned studies a new open source e-Learning platform is being proposed, the OWLearn platform, offering profiling and personalization services for the teacher and student while at the same time adapts the educational content and tools in the basis of the user’s profile. The proposed platform supports both synchronous and asynchronous e-Learning.

References