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Xedu, a Proposal of Learning Management System Implementation

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Abstract

Learning management systems (LMS) can be defined as a suite of services designed to deliver, track, report on and administer learning content, student progress and student interactions. Current LMS are based on courseware tools that mainly use Internet and the Web as learning platforms. However, they use proprietary/closed information technologies and formats such as HTML that are not adequate for developing and managing sophisticated educational applications. Moreover, they also lack adaptive features in order to allow the student an individualized learning. The current work proposes a LMS model based on standard and open information technologies such as XML, Java and Javascript. It also includes features to adapt the delivery of educational contents depending on specific user profiles. A LMS implementation called XEDU is being developed which runs on Apache Web Server and MySQL database.

Keywords: Learning Management Systems, Web technologies, mark-up languages

Introduction

Learning management systems (LMS) can be defined as "a suite of services designed to deliver, track, report on and administer learning content, student progress and student interactions" (ADL, 2003). The importance of these systems is growing as far as terms such as "Internet-based Educational Systems", "Educational Service Providers", and "Distance-learning" or "On-demand Education" are becoming popular. Information and communication technologies (ICT) such as Internet and the Web provide the perfect framework for current LMS. They are mostly based on courseware tools either commercial or coming from university research groups.

Some of them use proprietary multimedia authoring tools like Authorware™ or Tooolbook™ that bound the reuse and exchange of educational contents (Wiest & Zell, 2001). In other cases, they are based on formats such as HTML that seem adequate for presenting and accessing information in an open environment like the Web but lack a data structuring capability. Moreover, they also lack adaptive features such as navigation support or presentation control mechanisms.

The current work proposes a LMS model that is based on standard and open information technologies such as XML, Java and Javascript. XML (eXtensible Markup Language) (W3C, 1998) is a language that describes a class of objects called XML documents. These documents have been used to represent multiple kinds of information and their application is particularly important in educational contexts (Cap, 2000). An important contribution in the current work

consists of specifying most of LMS information items in XML-based notations. There are also related technologies such as XSL, XPath or XPointer that support the management of XML documents. They are used to process LMS information and to display it in different formats and platforms. Technologies as Java and Javascript are also applied to more complex XML processing services and they also improve the portability of the proposed LMS. The main LMS issues are:

- Strict detachment between authoring procedures and material formats, and their delivery. That means that the same course material could be exported to different "Course Delivery Systems".
- Use of open formats to define every kind of document from user input data to student tracking and scheduling information. Therefore, these documents should be able to be processed by means of external tools.
- Adaptation of navigation and presentation issues according to user preferences, learning goals or knowledge levels.
- Integration with several communication tools (e-mail, search engines, forum, news).

The implementation of these LMS requirements is called XEDU (Buendía et al, 2003) and it runs on Apache Web Server (Apache, 2001). Related server technologies such as PHP and database management systems such as MySQL are also involved in its development. It is not a "professional" free-error product but it is being applied in a local project (Buendía et al, 2001) and a Socrates European project called Theiere (Burguillo, 2002) in order to experiment the use of XML-based notations in advanced learning environments.

The remainder of the paper is structured as follows. Next section describes some related work about LMS. Third section presents the proposed model of LMS. Implementation details are reported on section 4. Finally, section 5 presents some remarking conclusions.

Related works

There are several proposals of “open and flexible” LMS in the sense they have features such as the use of non-proprietary formats, the distributed access and choice of the learning time/place or the personalization of teaching material for individual users. We are particularly interested into the organization of the teaching material (not only courses) and the facilities to manage it irrespective of the delivery medium.

Commercial products such as TopClass (WBT, 2001), WebCT (WebCT, 2001), or Learning Space (IBM Lotus, 2001) permit the use of open and non-proprietary formats of the Web like HTML and they are involved in the introduction of metadata standards (Duval, 2001). Current Learning Space version is AICC compliant (AICC, 2001) and it can interface directly with any course that has been written to AICC standards to provide tracking and management functionality. WebCT provides tools such as IMS Content Migration Utility that allows administrators to bring in or export content and assessment information from WebCT courses to ContentPackaging and Question & Test Interoperability formats (IMS, 2002). Authorware 6 (Macromedia, 2001) includes the SCO Meta-data Editor, which is based on the IEEE LOM specification (IEEE LTSC, 2002), meta-data formats (IMS, 2002) and SCORM Content-level specifications (ADL, 2001). However, these proposals mainly aim at using these metadata

standards as mechanisms to improve the interoperability with their courseware products and they bound the information to be managed in these open formats. Moreover, most of the commercial proposals rely on HTML links (or sequences of Web pages) to organize the course material and this hardens the way to manage such information.

Other options have developed more advanced “open” features and not bounded to courseware issues. For instance, Microcosm (Davis et al, 2001) provides a link service to connect multiple distributed learning applications, or Gentle (Maurer & Dietinger, 1997) that is based on the Hyperwave server which permits the organization of documents into clusters and collections, and the management of links as independent entities. ADL proposes a Shareable Content Object Reference Model (SCORM) that defines a Web-based learning "Content Aggregation Model" and "Run-time Environment" for learning objects (ADL, 2001). It combines elements of IEEE LOM, AICC and IMS specifications and expands them to include additional course structure capabilities. The Open University of the Netherlands proposes the use of EML (Koper, 2001) to codify units of study (e.g. courses, course components and study programs) in an integral fashion. It has an XML binding and an Edubox-player has been built that interprets EML files and creates a concrete learning environment. Our work is close to this proposal in the sense that we rely on an XML-based notation to represent every kind of learning information but we intend to cope with a wider range of learning structures (Buendía et al, 2002) rather than strict EML "units of study".

LMS model

The XEDU LMS is based on a model whose main services are described as follows:

Resource Authoring

This service addresses all the aspects related to the authoring of educational resources (see Figure 1a). Such resources are defined as every information item that is used for educational purposes. They are divided in two types: contents and structures. Contents represent the own data associated to the educational resources (based on multimedia formats, meta-data information or binary programs) while structures concern their organization in form of lists, taxonomies, or algorithms (Buendía et al, 2002). It is important to remark that courses are only a type of organization and they are managed such as any other structure.

There are several possibilities to represent contents and structures, for instance using standard specifications such as “learning objects” or “packaging structures” (IMS, 2002), “units of study” in EML (Koper, 2001) or “elements” and “templates" in Palo (Rodriguez et al, 1999). The current LMS functionality is independent from the particular resource implementations. At this moment, we are using LMML contents (Süß et al, 2000) and “ad-hoc” structures (Buendía et al, 2002). These elements are developed outside the system and the LMS only provides procedures to make them accessible.

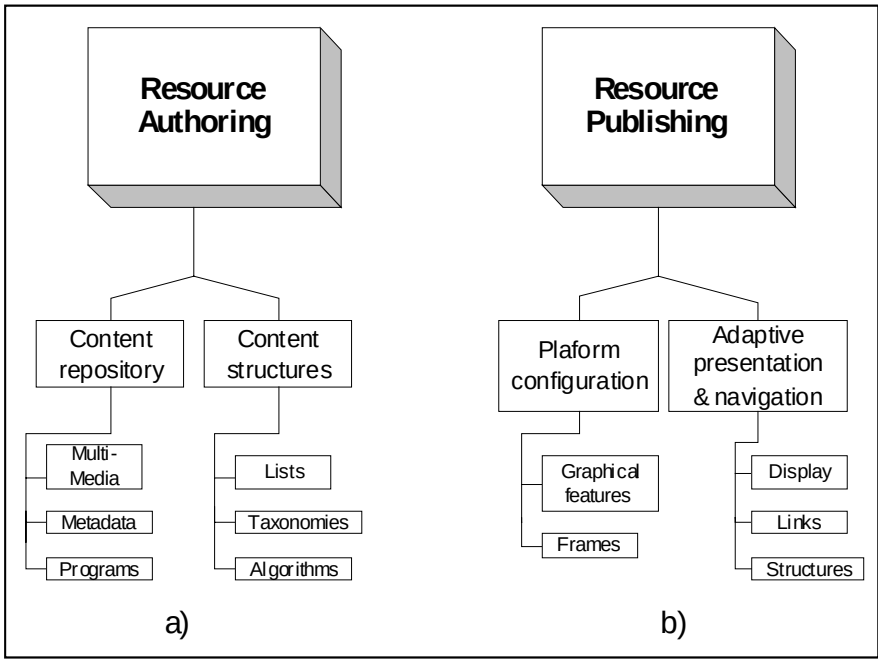

Figure 1. LMS Resource management functions

Resource Publishing

The publishing of educational resources depends on the selected structure (e.g. a course), the system configuration and the user characteristics (see Figure 1b). Each structure has assigned a specific presentation schema and a set of navigational tools. These structure schemas are tailored using a system configuration in which display parameters are set up (e.g. text fonts, screen background or frames assigned to each structure component).

The presentation aspects can also be dynamically adapted depending on the user preferences, conditions or status. The navigational aspects such as the selection of links or their direction can be also adapted.

User management

In this section, the services for managing the information about the user are described (see Figure 2b). This information comes from documents that contain personal data based on specifications such as Vcard (IMC, 2002) or the user knowledge about a given topic based on specifications such as Learner Information Package (IMS, 2002). Users can introduce their preferences using these specification formats. Profile users can also be configured from proposal such as ERILE (Lindner, 2001).

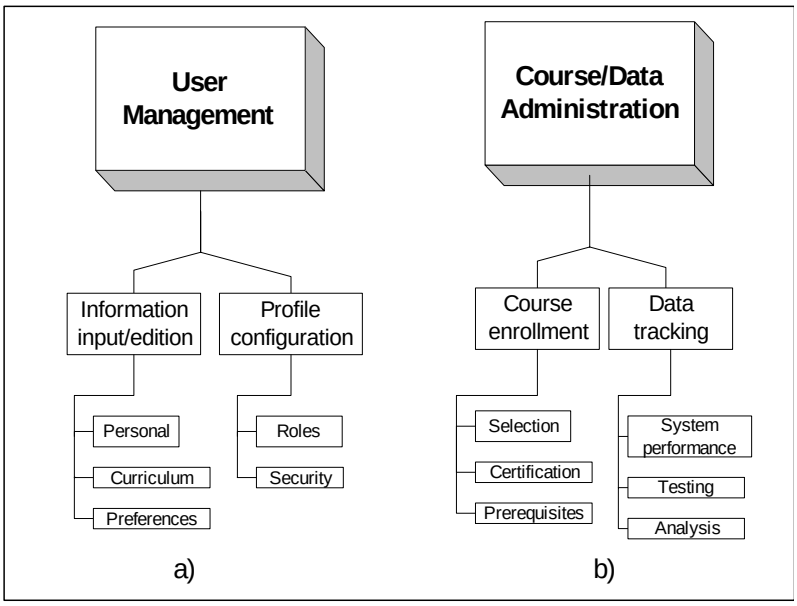

Figure 2. LMS User and Curse management functions

Course/data administration

These services are addressed to organize the aspects around a course, from the selection of the structures and contents to be taught to the tracking of the user accesses (see Figure 2b). They also involve the enrolment of users in a given course, the checking of prerequisites, its temporal scheduling or the setup of evaluation procedures. Finally, course certifications are produced and system analysis and user performance can be made.

LMS Implementation

The implementation of the previous services is performed in the context of the XEDU framework (Buendía et al, 2001). XEDU is being developed using powerful information technologies and its general structure is shown in Figure 3.

The main system is a Web application that runs on an Apache Web Server and it uses a MySQL database. This application is formed by several Java servlets (applications that run on the Web server) which process the XEDU information elements and a "Control" applet (application that runs on the Web browser) which calls for them. The "DBResource" servlet is addressed to manage the information related to educational infrastructure and stored in the database either for teachers or students. It is invoked when the required data are in a database format and they are converted to a DOM model which is transferred to the calling applet. There is another servlet ("XMLResource") that reads the information coming from XML documents (e.g. administrative procedures) and obtains the equivalent DOM model which guides the resource publishing. This servlet is also applied to perform the resource management since it allows the teacher to build its own educational structure for a given topic.

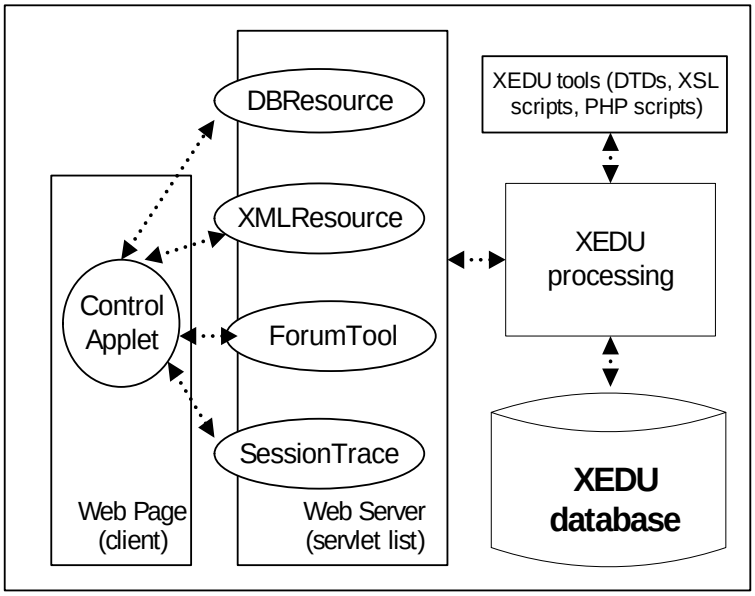

Figure 3. Xedu LMS implementation

There is available a starting empty XML template and teacher can introduce, by means of XSL scripts, a component hierarchy for this topic. Figure 4 shows an XML document that represents an example of component hierarchy. Such hierarchy is used like the content repository and its components can be organized in different ways according to the student requirements.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE MENU SYSTEM "Menu.dtd">
<MENU>
    <OPTION id=":0" title="Presentación" url="htmlFiles/ SMM/datosSMM.php"/>
    <OPTION id=":1" title="Trabajo" url="htmlFiles/ SMM/Trabajo/form_trabajo.php"/>
    <OPTION title="Prácticas" url="" id=":5">
        <OPTION title="Práctica XML (castellano)" url="htmlFiles/PFC1A/PracticaXML/login.php" id=":6"/>
        <OPTION title="Práctica XML (PDF)" url="htmlFiles/ SMM/PracticaXML/PracticaXML.pdf" id=":7"/>
        <OPTION title="Práctica XML (english)" url="htmlFiles/PFC1A/PracticaXML/login.php" id=":8"/>
    </OPTION>
</MENU>
```

Figure 4. Topic structure example

The "ForumTool" servlet deals with the management of the different communication forums in which users are involved. They are implemented as XML documents and their management is similar to the other educational resources. Figure 5 shows an example of forum display.

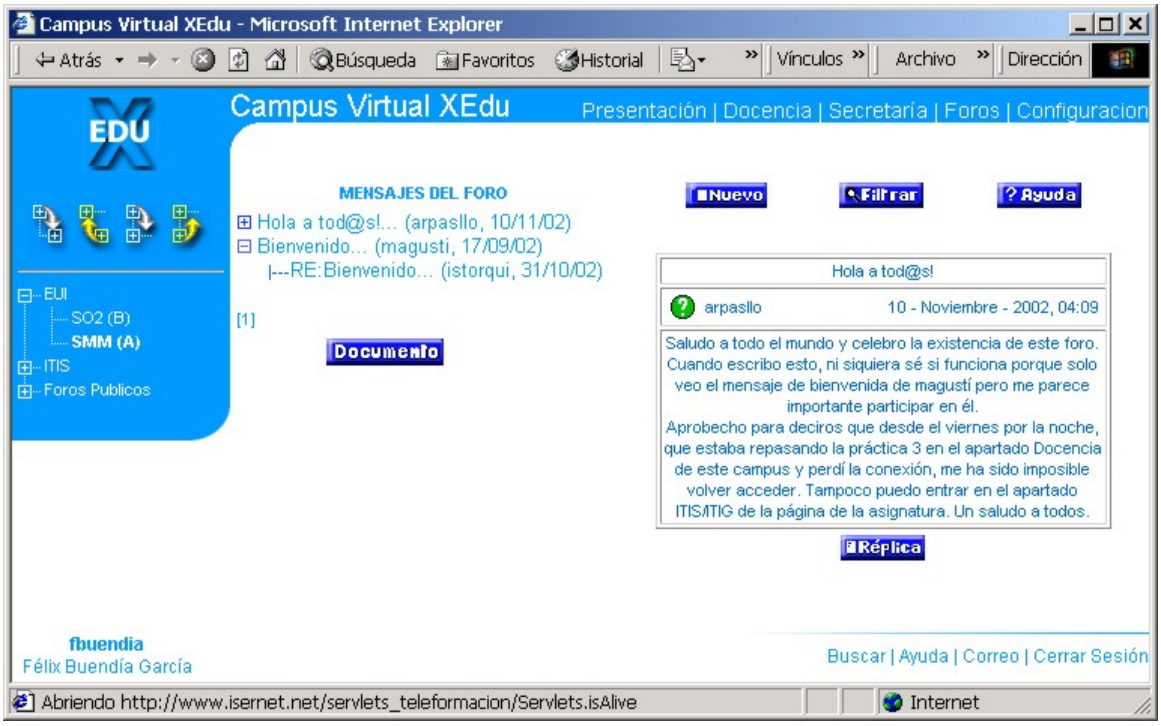

Figure 5. Forum management in Xedu

The "SessionTrace" servlet is addressed to store the session information that a user tracks. Figure 6 shows an example of XML document that gathers the session date, the interval of time and the accesses to the resource items. This information can be used to analyze the student behavior and, then, to configure their user preferences.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE log SYSTEM "log.dtd" >
<log>
  <session date="18/11/2001">
    <time start="9:42:14" end="9:42:57"/>
    <trace step="AC2D:8"/>
    <trace step="AC2D:1"/>
  </session>
  <session date="20/11/2001">
    <time start="9:56:14" end="9:57:11"/>
    <trace step="AC2D:1"/>
  </session>
</log>
```

Figure 6. Trace information example in Xedu

The resource publishing is based on the "Control" applet that configures the Web pages accessed by the users. They are divided into several areas or frames as Figure 7 shows. There is an upper frame that gathers the title and a set of general options such as Presentation, Classroom, Administration and Communication. The lower frame allows the access to utilities such as Search, E-mail or Help. When the user clicks on a option like Classroom, the left frame is assigned with an index map attached to the material structure. The main frame is used to show the content information (e.g. the content of a practice activity about XML that Figure 7 shows).

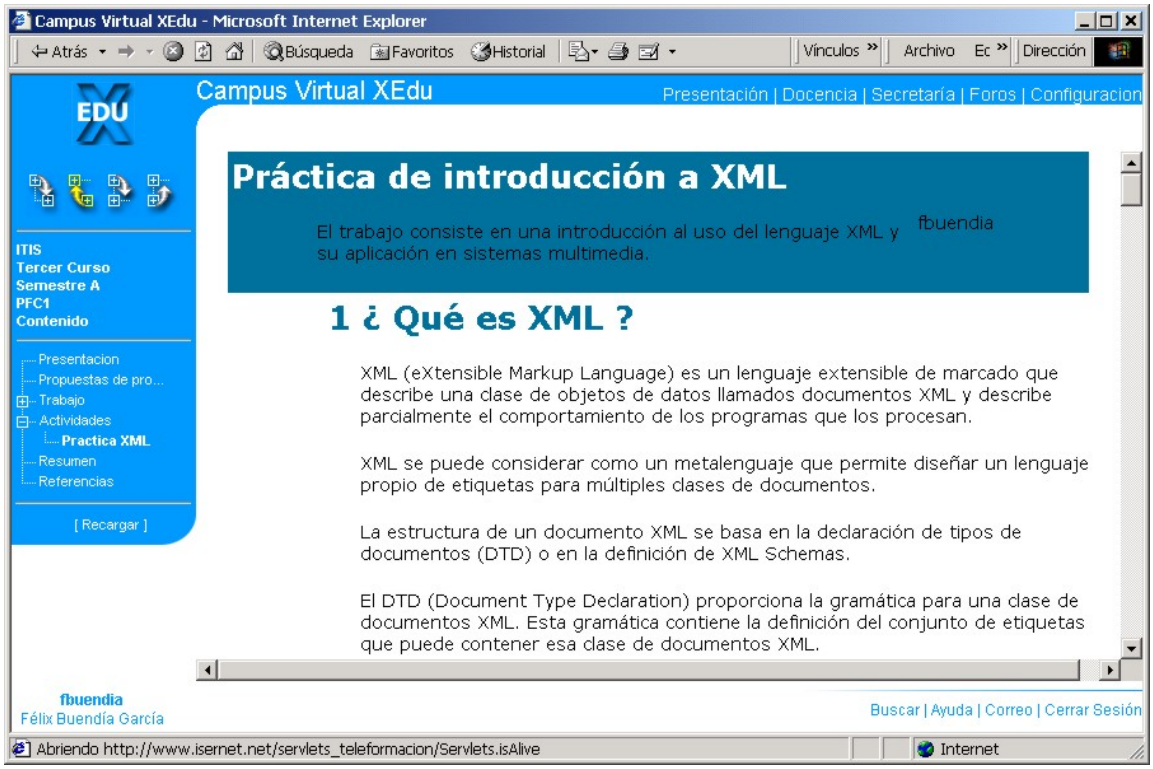

Figure 7. Content publishing in Xedu

The introduction of user information can be performed in two ways: batch or interactive. The first option is based on XML documents that store the user data and these are uploaded to the server to be processed. The interactive option uses forms that are generated from the XML template in a dynamic way. An example of this procedure is shown in Figure 8. Every user has a login and a password that are checked using a PHP authentication function. SSL security services are planned to be included. At the moment, there are three user roles: student, teacher and administrator. Students have different options such as current course material and assignments, administrative tasks (e.g. course enrollment) or communication tools (forums, e-mail, etc).

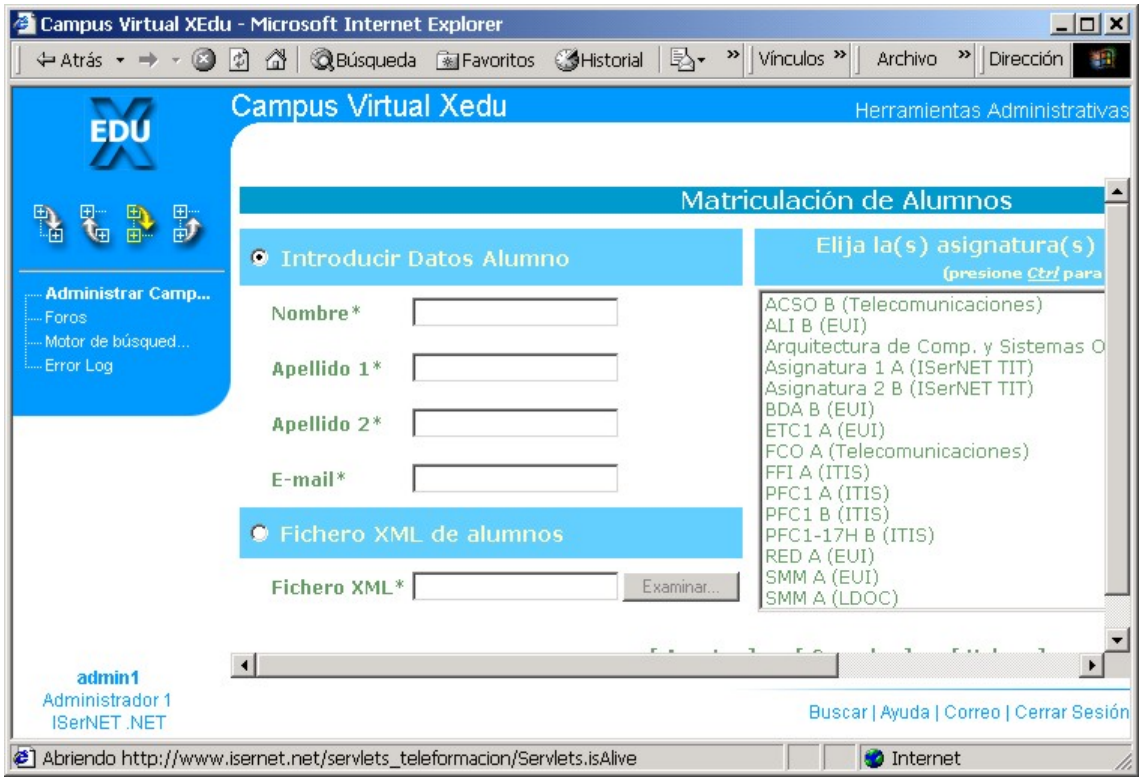

Figure 8. Student information screen

Teachers are concerned with the material insertion (also implemented in the "DBResource" servlet) and the setting of assignments. Figure 9 shows an example of introduction of teaching information. Administrators control the system running and they have options such as the configuration of communication tools and the system error management. Whenever a user, like a teacher or a student, accesses to the system, he is asked for resuming the “last” structure option he reached in a previous access. This information is stored by means of the "SessionTrace" servlet. Administrator users have special rights that allow them to supervise the system log or control the student access.

Conclusions

This paper shows the design and implementation of a LMS example called XEDU. It takes advantage of standard Web information technologies such as XML, Java and Javascript. The first one permits the strict separation between resource elaboration and its publishing in different formats. The use of Java and Javascript programming languages improves the XEDU portability. We are experimenting an XEDU prototype that is working on a Unix/Linux and Windows-based servers. The system has registered a hundred of students and near twenty teachers, and the application performance is good. The main contribution that teachers recognize is the possibility to use references to external resources and the exchange of XML documents that implement resource and user organization.

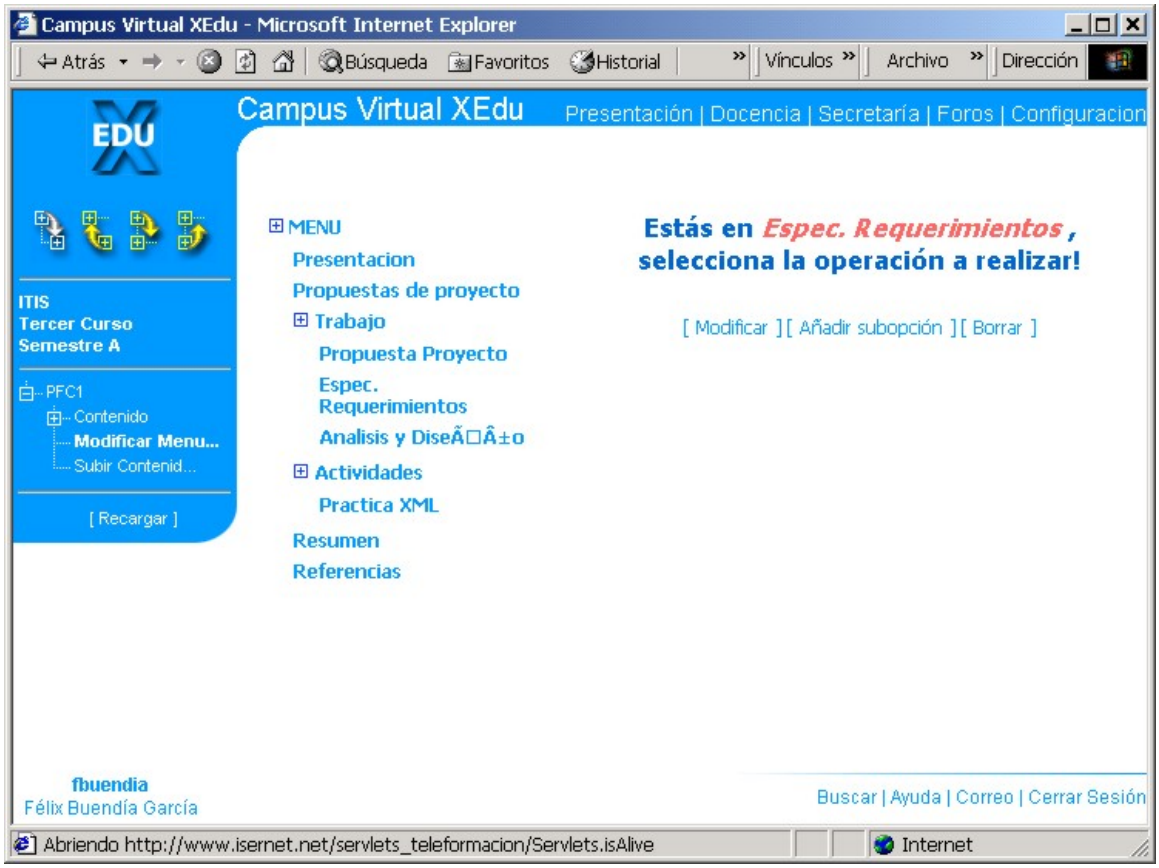

Figure 9. Teaching information screen

Currently, we are checking its application in several computing subjects at the Informatics School (Polytechnic University of Valencia). Teachers who are responsible for introducing learning material are focused on its elaboration and they are not concerned about the presentation details. This feature eases their teaching task. More complex educational structures and applications are planned as future works. On the other hand, students have the possibility to deliver their assignments in a format that can be easily processed by the teacher.

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