OPEN SOURCE LMS CUSTOMIZATION
A Moodle Stadistical Control Aplication

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Keywords: Learning Management System, eLearning, Moodle, Aplicación de Control Estadístico de Moodle, Content Management System, Learning Content Management System, Sharable Content Object Reference Model, Web Accessibility, What You See Is What You Get, Graphical User Interface, Database, Data model, Architecture, Authentication, Installation.

Abstract: This paper reflects the possibility of doing adaptations on a LMS depending on the necessities of a company or institution. In this case, ACEM allows the definition of course-level and platform-level reports and the automatic generation of certificates and diplomas for Moodle LMS. These adaptations are intended to complement all the different learning platforms by contributing added-value features like the generation of customizable diplomas and certificates and reports, which allow the obtaining information about both grades and participation in every activity of a course. All this necessities are not provided by default.

1 INTRODUCTION

Lately both state and private institutions are betting on eLearning solutions so as to satisfy their formation necessities. Any of the kinds of formation which can be offered should rely on a complete and flexible enough technological support, that is, a Learning Management System (from now on, LMS). These systems are in charge of the different actions involved in the online formation process, which includes the student management and providing them with resources and activities. Because of this, the eLearning cannot be implemented without the support of an LMS.

Nowadays, many different LMS can be found in the market. Commercial LMS generally offer a higher level of customization, incrementing the final price. On the other hand, those which are based on free software have the advantages derived from this kind of software but they will not adequate so much to additional requisites.

Among free distribution LMS it must be mentioned Moodle, which is a project designed to support a framework for a constructive social education (Comezaña & Garcia, 2005). Currently, it is one of the most extended LMS in the world. It also has a large community of users and developers. Despite this large community behind it, Moodle does not adapt to all the necessities that can arise.

The problem arises specifically from a particular necessity of *Centro Internacional de Tecnologías Avanzadas* (CITA), belonging to *Fundación Germán Sánchez Ruipérez*. Its objective is achieving an optimal qualification management and a system which allows them to generate diplomas and certificates. This situation must be resolved without providing a new platform, but developing an independent web application which can be used on the top of the instance of Moodle being used now.

In order to resolve this necessity, it is proposed the creation of ACEM (*Aplicación de Control Estadístico de Moodle*) which will be an application independent of Moodle and will provide the desired functionality without having to alter the data obtained from any instance of this LMS.

Some of the current LMS in the market will be described, and detailed their limitations about dealing with grades and their management of certificates and diplomas, with special interest in Moodle. After that, it is commented the development model in Moodle and the difficulties which are

Muñoz C., Ángel Conde M., Reyero J. and Garcia F. (2008).
OPEN SOURCE LMS CUSTOMIZATION - A Moodle Stadistical Control Aplication.
In *Proceedings of the Fourth International Conference on Web Information Systems and Technologies*, pages 402-407
DOI: 10.5220/0001525204020407
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raised depending on the distribution of the data in the LMS. Finally, the developed product is shown and the conclusions and future work lines are listed.

2 CURRENT PLATFORMS AND THEIR LIMITATIONS

New necessities arise from the experience with the usage of knowledge management platforms. It is necessary to understand and realize the limitations which these platforms have and also the objectives which are intended to achieve, so that they do not involve an obstacle when deploying.

Although it is obvious that there is not a panacea capable of solving all the limitations which these platforms show, it is simple to observe that some basic functions are not supported.

The first limitation which arises when dealing with LMS platforms is just its own definition. They are systems for managing the learning process but generally they do not include other interesting aspects, like an adequate content management which enables the creation of content within the platform, that is, the typical features of a CMS (Content Management System) which turns out to be very useful for this kind of platforms.

The so-called LCMS (Learning Content Management System) arise so as to solve this separation, but its extension, apart from scarce, is basically reduced to proprietary tools for specific usages (Rengarajan, 2001).

Another limitation shown by LMS platforms is the absence of implementing standards which enable an easy migration of learning objects between platforms (Maurer, 2004). An approximation which represents a solution is the implantation of the necessary functionality for the correct processing of packages, like SCORM (Sharable Content Object Reference Model) (Jones, 2002). Thus, learning objects can be transferred between platforms without having to redefine the contents on each platform.

Another lack of functionality in LMS platforms is related to the graphical user interface management, which is derived from the features of any web application. Although the concentration for this kind of platforms should be in the learning process itself and the quality of contents, important interface aspects like Web Accessibility should never be neglected.

From a statistic point of view, there are not usually platforms which have a wide range of statistics about their usage, their administration or, more specifically, the grades of the students who use them. What is more, they do not include any graphical representations which help to take decisions about, for example, the way of posing or presenting contents. Taking into account the importance of some aspects like feedback, the features previously mentioned become necessary if a high level of satisfaction of all the involved parts is desired. And this satisfaction is a key element for the success of any kind of platform, especially in the case of a LMS platform.

An unsupported concept by LMS platforms arises as a result of these statistic properties: the idea of portfolio associated to each student, seen as a curriculum which shows the student's progress and achievements or even information related to learning modalities like in-person or blended (blended learning). Taking the different phases of the learning process into account, many platforms in the market cannot cover the whole process due to, basically, the lack of methods for certificating or generating documentation which proves the acquisition of certain knowledge.

Finally, leaving aside the technical features, another handicap which these platforms have to face is their necessity to be correctly managed by qualified personnel.

In general, these limitations are not applicable to every single existing platform but each platform presents a subset of these limitations which forms a base for the implementation of possible improvements. The identification of the weakest points of those platforms will depend on the objectives or requirements which are intended to fulfil and, therefore, a research for helping to choose the most adequate option should be made.

3 THE CASE OF MOODLE

Moodle is a kind of LMS platform aimed basically to provide a set of tools and structures which enable adapting the learning model to an online one.

As a result of the nature of LMS platforms and Moodle in special, the lack of a direct communication between the teacher and the students, or even, among the students, makes the system be responsible for this communication. These refer to the necessity of providing a set of functionality which will substitute the exchange of information between them.

In order to achieve this goal, the techniques used are based on statistic methods for compiling information. As for Moodle, although it provide

methods for evaluating the different activities, it does not generate relevant statistics about the evolution of the students based on either their grades or other measures considered useful for these cases.

Besides these problems, the grades management system of Moodle has its own gaps. Moodle groups the students of a subject of course into groups, and each of them can have a disjoint set of those students. This layout, along with the characteristics of the group, enables the interaction with the students depending on the definition and permissions associated with that group (Castro, 2007). However, the problem arises when establishing the grades. This organization in groups is not extended to the classification of students.

As for the achievement of the results of the course, grades obviously are the main scale of measure. Considering grades as the main element of the metric, some kind of organization of the students depending on certain ranges of grades is missed in Moodle, which will allow the user to obtain the percentage of those who are included in each range. Thus, the quality of the knowledge penetration on the students could be measured in a moderately accurate way, depending on the number of factors taken into account: the more factors, the more accurate measure. This measure, along with other aspects, could be established as highly adequate rates so that the teachers could readapt the contents in order to increase the reach of the required knowledge. Another possible factor to be measured should be the presentation rate of those activities.

As it can be observed, the possibilities of system improvement that Moodle leaves open are considerable. However, there is another relevant limitation shared by most of the LMS platforms: the inability to cover the whole learning process, especially the final phases.

More specifically, Moodle does not allow the generation of any kind of certification for each student which would identify him as a holder of the knowledge learned in the course. This would require some kind of module which allow the generation of diplomas, in an automatic and systematic way.

Besides all these limitations, Moodle have some positive features which make it one of the most used LMS platforms. The objective of the description of its limitations is to state that though the functionality of these platforms is usually wide and flexible, they are not able to cover all the goals considered relevant by those who use them.

4 THE DEVELOPMENT MODEL IN MOODLE

The development in Moodle can be tackled in different ways depending on the desired level of independence from the platform:

- **External Applications**: an application which uses the platform database without having to make any integration with its interface.
- **Module Development**: it consists on building new modules which can be integrated into the platform.

Based on the client's necessities, the first option is chosen. These necessities specify certain requirements whose fulfilment is more adequate to a non-integrated solution. Once considered this choice and taking into account the goals of the application to develop, two architectures can be proposed so as to obtain the maximum scalability possible.

4.1 Suggested Architectures

Firstly, a solution based on a external application with access to the database of Moodle is suggested. A diagram representing this architecture is shown on the Figure 1.

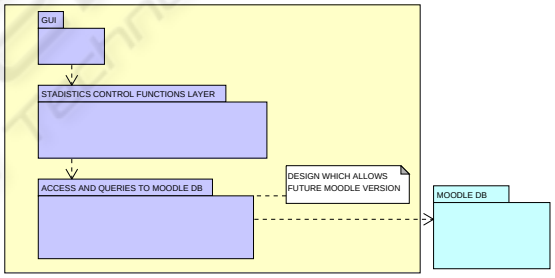

Figure 1: ACEM first architecture proposal.

This application will access its database directly and it will be structured in the following layers:

- **Access and Queries to Moodle DB**: this layer will contain the necessary functions to perform queries on a Moodle database. It is proposed the utilization of query description files. This layer also abstracts the statistic control functions layer from the data searching process.
- **Statistic Control Functions Layer**: this layer will use the functions located in the previous layer so as to perform the statistic control.
- **GUI**: graphical user interface.

The second architecture suggested is based on an application linked to Moodle which uses the new database access features of version 1.7 with full

support for version 1.6. This architecture is shown in the Figure 2.

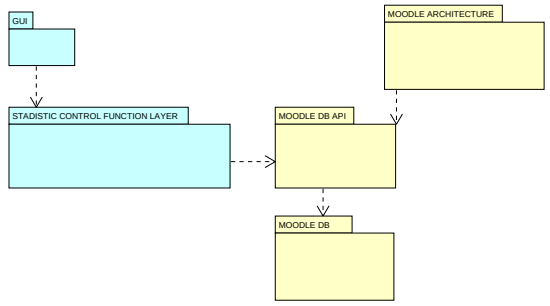

Figure 2: ACEM second architecture proposal.

In this case, the layers to be developed are these:

- **Statistic Control Functions Layer**.
- **GUI**: Graphical user interface.

Here, the database access is performed via the new API which Moodle provides in the version 1.7: Moodle DML Library (Lafuente & Hunt, 2007) and Moodle DDL Library. Finally, the client chooses the first option.

4.2 Obtaining the Data Model

The development can start once its model has been defined. Developing Moodle based software involves several difficulties. One of the most representatives is the little knowledge about Moodle database because neither its data model nor the used tables are public. Thus, in order to find out that information, reverse engineering (Hainaut, Tonneau, Joris & Chandelon, 1993) methods have to be used. Considering the data model obtained, a research must be done so as to determine how Moodle fills the data tables corresponding to the element to be analysed. Specifically, one or more tables will be queried for each of them because of the data distribution in Moodle and the necessities of the application as well. Some of those tables are:

- User related tables: they will give information about the users (students) of the platform.
- Resource related tables: they will give information about the existing resources.
- Graded activity related tables: these will allow the calculation of the grades at course-level and platform-level.
- Not graded activity related tables: used for doing a list of activities for the reports.
- Course related tables: these will give all the information about the existing courses.

Once the information necessities and the way of retrieving it are defined, some research on the possible situations which might involve an update of the data stored in the tables mentioned before needs to be done.

The table which associates the different activities with a course is built from the data of many other tables and the information is updated only when the teacher or student access the grades section of a certain course. This means that, when generating a platform-level report, it would be necessary to access the grades of each course manually every time a change happens. The option chosen to avoid that is “touching” the courses involved in the desired report. This method will consist in logging in each course automatically and access to the grades web page (grades.php) in a totally transparent way for the user. This technique is effective but after some testing, it was noticed that Moodle might have an alternative login page, so this case must be taken into account.

Nowadays, some significant delay is produced when testing this technique with a large number of students. Because of that, it might be changed for retrieving that information by doing direct queries on the database as it is done when dealing with grades.

4.3 An Error in the Grade System

After researching on grade calculation methods, a possible defect in the grade system of Moodle has appeared. The platform weights all the grades and can also weight them a second time if the correspondent option has been enabled by the user. It appears that this might lead to an error, because the final grade of a student does not correspond to the logic expected. It has been observed that Moodle does weight grades although it has been asked not to do it when doing some testing.

5 GENERATOR OF REPORTS, DIPLOMAS AND CERTIFICATES

In the following lines, it will be described the functionality obtained in the generator of reports, its main elements and the development difficulties.

5.1 Functionality

ACEM was built as an application for a certain client but after considering the limitations of Moodle which have been overcome, it has been decided to

use it as an add-value component for that learning platform. The application implements the following functionality:

- **Platform-level Report Generation**: this option enables the obtaining of statistic data related to the whole platform. The generated report will reflect data related to all the students in the campus, the users, some generic information about the courses, the resources and the activities grouped by their type, as well as information about the grades in the platform. Information of final report can be complemented with data typed by the user. The data of the generated document are shown in several ways as it can be observed on figures 3 and 4. Any of the documents generated can be obtained in different formats like PDF, HTML or MS-WORD (.doc).

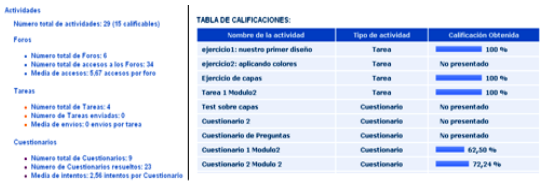

Figure 3: Information in list and table mode.

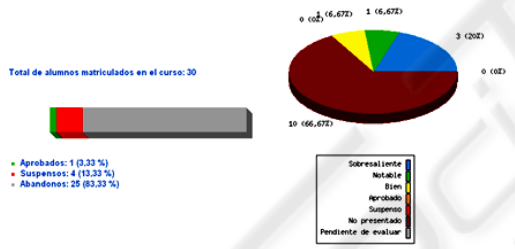

Figure 4: Bar and pie chart.

- **Course-level Report Generation**: the information of this report is about the number of students, resources and activities of a course and the grades as well. The user is allowed to enter a head text and footer. It can also be exported to different formats.
- **Diplomas and Certificate Generation**: the application also provides a tool for defining customized diplomas for the students. Some of the elements which can be configured are: the image logos, the title, the institution name, etc.

5.2 Some Components of the Application

Three different layers are distinguished in the architecture shown on figure 1. Other elements which are not shown in the diagram are the authentication component and the installation component.

- **GUI**: It is very important for any application to have a user interface which enables a simple and efficient access to its functionality (Gándara, 1995). The technologies used for building it are HTML, PHP and CCS (Cascade Styling Sheets).

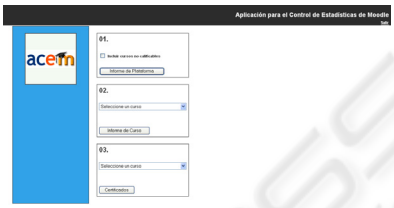

Figure 5: ACEM GUI.

- **Authentication**: ACEM deals with personal data, so the access to this data must be controlled. A component for authentication will check if the user has logged in correctly. The system uses HTTP sessions (Welling & Thomson, 2003) to check it.
- **Installation**: ACEM will need a process of installation and configuration. In this particular case, it will be checked if a file called "config.php" exists and if it does not exist, the web page for the basic configuration of the application will be shown.
- The type of the database which will be used along with its name, a user and the correspondent password.
- The Moodle administrator's username and its password.
- The URL of the installation of Moodle to be used and the one of the login web page.
- The username and password to access ACEM.

5.3 Difficulties found During the Development

The development of any software applications involves some difficulties. In this particular case, most of them have appeared from the necessity of researching on different PHP libraries which were not known by the developers. Another big problem is the time efficiency of the suggested solutions.

For the generation of charts it has been chosen a free software PHP library called PHPlot (http://sourceforge.net/projects/phplot/).

As for PDF files, the first choice was using FPDF library (http://www.fpdf.org/) for generating the certificates and diplomas and DOM PDF

(http://sourceforge.net/projects/dompdf/) in the case of reports. FPDF allows the generation of complex documents but it needs every element to be positioned within the document, what can be really difficult for a large documents. This is the reason why DOM PDF is used for generating the reports because this library allows the automatic conversion from HTML to PDF. However, when the number of students grows up and thus the size of the documents generated, the time spent in generating the reports is unacceptable. Therefore, the generation of reports will be done using FPDF library as well, although it involves much more time to develop.

For generating MS-WORD documents (DOC), several libraries were researched on, but none of them worked properly so the final choice was generating a HTML document and then changing its file extension to .doc because, currently, MS-WORD converts automatically from HTML to DOC.

Another difficulty is the increase of time due to the large number of database queries to be done. The number of queries to execute was reduced and a cache of query results was implemented. Thanks to this, the execution time was reduced to a fourth of the original time, though we are still working on it.

6 CONCLUSIONS

An added-value tool for a LMS platform has been developed by using web technologies.

By observing the different LMS platforms in the market, it can be noticed that most of them do not provide enough graphical representation about the students' activity and they do not allow the generation of certificates or diplomas either. In particular, Moodle does not include those features.

Several options for developing the application have been taken into account and an external application has been defined. ACEM allows users to obtain information in many ways, like documents, charts or diplomas which enhance the information stored by the platform. Nowadays, this kind of information is fundamental for the management of studies in a learning platform.

The development of the application has involved doing an exhaustive research on the data model of Moodle, its management and the way it deals with grades. After doing it, a set of queries has been defined so that the application can use them for obtaining de requested reports.

The aim of the application is generating the most complete, representative and useful reports. The current application version is 1.0, although the development will be continued so as to improve its functionality and thus enhancing Moodle.

7 FUTURE WORK LINES

As for the possible evolutions of the application, there are several options to work in:

- **Graphical Representation Methods**: Information Visualization is a computer science area in develop (Rohrer & Swing, 1997).
- **Improve MS-WORD document generation**.
- **Reduce report generation times**.
- **Include new graded Activities**.
- **Adaptation to new Versions of Moodle**.
- **Build ACEM as a Moodle Module**.

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