Modeling and Comparison Study of Modules in Open Source LMS Platforms with Cmapstool

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Abstract — **This work is part of a first phase of the project "DOMAIN SPECIFIC MODELING FOR THE LEARNING OBJECTS BUILD PLATFORM-INDEPENDENT " and seeks to make a comparison between Open Source LMS to get a first approximation of common modules them, and then start building the ontology compatible with all LMS studied, for that reason this paper is organized as follows: 1.Select Tools to work. 2. Contextualization of LMS tools to work. 3. Leaning Objects. 4. Structure of the LMS. 5. LMS ratings. 6. Creating the map of knowledge for each LMS. 7. Comparison between the LMS modules modeled and 8. Conclusions.**

Key Words — **MDA, MDE, DSL, Ontology, LMS, maps of knowledge. Learning Objects.**

I. INTRODUCTION

'T'his work is part of the research line in Model Driven Engineering (MDE) of the Phd Programme in Computer Engineering of the University of Oviedo, Spain, the name of the project is *"DOMAIN SPECIFIC MODELING FOR THE LEARNING OBJECTS BUILD PLATFORM-INDEPENDENT"* and is looking for domain specific modeling for the construction of learning objects platform-independent, the stages of this project are: 1. Generate an ontology for modeling courses under a standard, 2. Using the ontology generated for create a Domain Specific Languages (DSL), 3.

Finally with Model Driven Engineering (MDE) and applying the appropriate transformations are achieved from a platform independent model a module deployed into a LMS built on a standard.

This work is part of the first stage of the project and the aim is to make a comparison between all LMS to work to get a first approximation of the common modules between them, and then start building of the ontology compatible with all LMS.

II. ANALYZE OF TOOLS

At present there are many Learning Management Systems (LMS), these LMS usually taking some form of standardization in its construction, according to [1] there are more of the 101 standards, regulations or recommendations regarding the e-learning, developed by 23 different organizations, we will conduct a detailed study to analyze from the standpoint of computing, the content of some Virtual Learning Platforms (LMS) to define a comparison table between them, the main criterion for selecting the platforms is the adoption of GPL licensing and open source, this condition with the aim of facilitate the analysis of his behavior and its modules. For the selection of virtual learning platforms, were used the studied realized in the thesis doctoral [2] for the definition of a universal learning platform, open and scalable approaches in social, political, economic and educational, with a view to identify from these points of view, tools that have evolved hand in these contexts, as well as from the methodological point of view the work of [3] to identify mechanisms that support the learning process of students in these environments work. In the same way it took into account reports by the group [4] SIG Open-Source Software for Education in Europe, which is funded by the e-learning program of the European Commission in consortium of several research groups and European universities, which present functional studies of computer free platforms, using a methodology developed by this project and sheltered by the ISO IEC 9126, identifying patterns of evaluation through elements such as: functionality, usability, reuse, efficiency, maintainability and portability, these platforms must support standards in your development and specifications of content, that is an issue of paramount importance to the goal we wish to

study end.

From the standpoint of the movement and use of free software, it pays to rescue the working done by [5] which presents important factors, this factors together with previous work concerning from the standpoint of allowing computer content define the following platforms of study: DotLRN, SAKAI, ATutor, Claroline and Moodle, which for purposes of collaborative work by the group [4] represent a good degree of acceptance and a good evaluation in most communities and working groups devoted to topics related to management course content and strategies in learning.

III.   CONTEXTUALIZATION OF LMS TOOLS TO WORK.

A. Sakai

This project originated at the University of Michigan and Indiana University, which later joined the MIT and Stanford University, along with other organizations and foundations in 2004. It is an LMS, which from the beginning has worked under IMS standards, which puts him in a favorable position relative to other LMS, this is because some of the masterminds of Sakai are the institutions carrying out these standards. Sakai provides a modular structure built to specifications of Java code which aims to integrate training and communication capabilities.

B. Atutor

This platform started as an initiative of the University of Toronto in 2002 in their school Adaptive Technology Resource Centre (ATRC). According to studies by the group [4] the development of this platform has paid particular attention to accessibility, becoming the only LMS that meets the accessibility specifications mandated by the W3C by standard WCAG 1.0 Level AA , which indicates the ability of the platform to allow entry to people with disabilities.

C. Claroline

It was a project sponsored by the University of Louvain in Belgium in 2000. It is considered a project for work on the approach of training through e-learning strategy and collaborative work using e-working strategy to be presented also as a content management system CMS.

According to the results obtained from the group [4] many universities appreciate the collaborative learning environment enabling teachers and educational institutions to create and manage Web-based courses. The tools provided by the system are many and give users the possibility of establishing a variety of learning scenarios.

D. Moodle

This project is one that has been more accepted in most academic and research community worldwide. As one of the first projects under the initiative GNU which gave its creator Martin Dougiamas. its host in the community was so good, that from the start began to adapt methodologies from the pedagogical point of view, social constructivism works and

tries to implement some recommendations of the standards.

Structurally is a platform that has all the characteristics apply to the development of components that allow interoperability with different levels of functionality to work. Its same name describe him as a Module Object-Oriented Dynamic Learning Environment

E. DOTLRN

DotLRN or .LRN was initially developed by MIT. DotLRN is currently supported by a worldwide consortium of educational institutions, nonprofit organizations, enterprises and open source developers. DotLRN is appropriate for learning and research communities, it has management skills courses, online communities, content management and learning. Consortium member institutions working together to support progress of each, to accelerate and broaden adoption and development of dotLRN.

IV.   LEARNING OBJECTS

It is not easy to find a definition of what a Learning Object but McGreal Roy in [6] dares to define them as educational resources that can be used in any technology to support education, a learning object allows and facilitates the use of educational content through internationally accepted standards and specifications to achieve interoperability and reusability in different applications and different learning environments.

Andreas Holzinger in his article entitled Multimedia Learning Systems based on IEEE Learning Object Metadata (LOM) [7] defines the structure of the LOM into three parts one element at the top called the root, which contains additional sub-elements called branches and these in turn have other sub-elements called leaves they no longer have anything else, has this hierarchical structure is called a tree, graphically displayed in Figure 1.

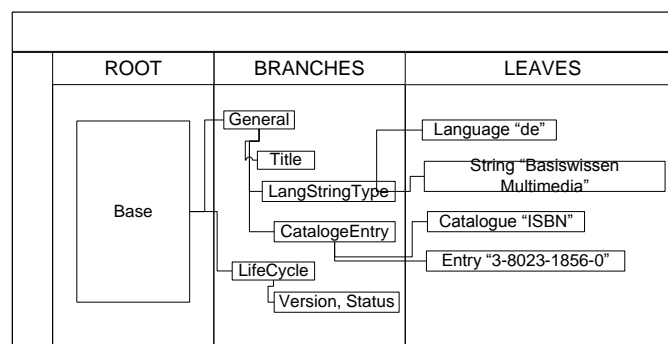Figure 8 A hierarchical model of LOM given by the IEEE based in [7], Source Author

V.STRUCTURE OF A LMS

According to McGreal Roy [6] learning experiences classes or groups are considered as modules. A module usually consists of at least 10 hours of learning. When the lessons are more than 10 hours or if they consist of more than one module is considered as a course. A group of courses leading to a

certificate or diploma is considered as a program, Figure 2 shows the proposed plan.
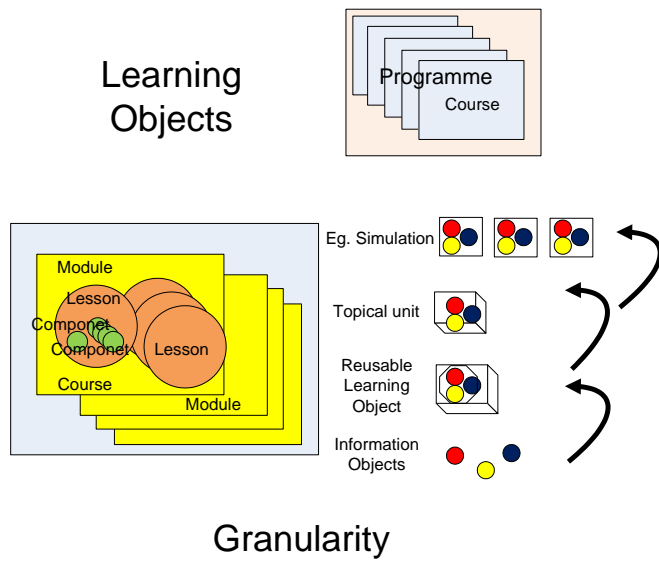

Figure 9 Granularity of learning objects, based in [6], Source Author

In the work "*Package and Visualization of SCORM LO into OpenSource LMS's*" [8] performed a content packaging under SCORM 1.2 on the ReLOAD software and then imported the package from Dokeos, ATutor, ILIAS and Moodle, one of the conclusions of this work is that the use of content publishers still not easy enough, because the concepts of learning objects and standards are not widely known, also the editor in ReLOAD software, is in English, and although there is the option to change into other languages, is inadequate as it modifies only a few terms. All this makes building, editing and packaging of digital learning content in SCORM, it remains underutilized.

EduTools is an entity that offers independent reviews at LMS platforms, comparisons between LMS and consulting services to help decision making in e-learning, about what LMS selecting according your need[9], the Table 1 show the result of the query made in the portal Edutools.com, with the filter Instructional Design Tools and Instructional Standards Compliance belonging to the area of Content Development Tools, there is evidence of the existence of design tools that help instructors creating learning sequences and adoption of standards in the selected LMSs, all the LMS have standards adopted, but each implements the standard according to your needs, and this is causing compatibility problems between them, to end this chapter in the Wiki [10] speak of the problem that concerns us *"problem Integration of LMS components, interoperability across multiple LMS"*.

Product Name	Content Development Tools	
	Instructional Design Tools	**Instructional Standards Compliance**

Claroline 1.8.1		IMS Content Packaging 1.1.3, IMS Content Packaging 1.1.4, IMS QTI 2.0, SCORM 1.2, SCORM 1.3
dotLRN/OpenACS	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable.	IMS Content Packaging 1.1.3, IMS Content Packaging 1.1.4, IMS QTI 1.2.1, IMS Enterprise 1.1, SCORM 1.2
Moodle 1.9	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable. Instructors can create linear learning sequences organized hierarchically by course, lesson, and topic. Instructors can reuse courses as templates for future lessons.	AICC IMS Content Packaging 1.1.3 IMS, Content Packaging 1.1.4, IMS QTI 1.2.1, IMS Enterprise 1.1, SCORM 1.2, SCORM 1.3
Sakai Community Release 2.5	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable. Instructors can create linear learning sequences organized hierarchically by course, lesson, and topic. Instructors can reuse courses as templates for future lessons.	IMS Content Packaging 1.1.4, IMS QTI 1.2.1, IMS QTI 2.0, SCORM 1.3
ATutor 1.6.3	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable. Instructors can create linear learning sequences organized hierarchically by course, lesson, and topic. Instructors can reuse courses as templates for future lessons.	IMS Content Packaging 1.1.3, IMS Content Packaging 1.1.4, IMS QTI 1.2.1, IMS Metadata 1.2.2, IMS Metadata 1.3, SCORM 1.2

Table 3 Product Comparison [9]

VI. Ratings of the LMS

For the taxonomic classification of the components of the LMS's, be will use an experiment-practice method, that

method was to work with each of the platforms and through its use and management, determine the taxonomy of their components, to the work of layout was decided to use a software tool that would provide easy graphical representation through maps and of freely distributed at this stage basically studied two; FreeMind [11] [13] and CmapTools [12], CmapTools finally opted for offering more ease for collaborative work Web, which has a variety of formats for exporting the map and a good number of projects such as [14] [15] [16] [17] [18], worked with her. To work with this tool is defined the following pattern:

- The relations between the LMS and the first elements are "*resources*."
- Concepts: The names of the concepts should always begin with an uppercase letter if the name is composed by more than one word the second, third and nth word must be written all in lowercase, to make the description of the component, this should be performed in the same component after his name and in parentheses, for example: "This is a concept (component description)" The concepts identified functional modules of the LMS and all concepts that are leaves (terminal concepts) must correspond to elements of the GUI (Graphical Interface User) that the user accessed directly, this elements were classified according to Table 2.

Text box (Caja de texto)	Explorator (Explorador)	Calendar date (Dato calendario)	Event (Evento)
Combo box (Menu desplegable)	View (Vista)	Text area (Área de texto)	Link (Vinculo)
Non editable text area (Area de texto no editable)	Button (Boton)	Radio button (Boton de opcion)	Color palette (Paleta de colores)
Tree (Arbol)	Check button (Boton de chequeo)	List (Lista)	Calendar (Calendario)

Table 4 Concepts leaves (terminals) in an LMS, Source Author

- Word Link: The name of the linking words should always be lowercase and no spaces, for example: "thisisalink". We define three types of links in accordance with the following assumptions: all leaves nodes must be of some type of the GUI (tipo). The resources (recursos) and sub-resource (subrecursos) must be composed of other sub-resource (subrecursos) or leaves nodes. The resources initial of the LMS will be called resources (recursos) and thereafter will be called sub-resource (subrecursos). The Table 3 classifies the links.

Word link	Description
resource (recurso)	The resources initial of the LMS
sub-resource (subrecurso)	Intermediate relationships, that are not first relation and are not leaves nodes.
Type (tipo)	All leaves nodes, must be some type of the GUI

Table 5 linking words for classification of LMS, Source Author

- The actions of accept (ok, aceptar) and Cancel (Cancelar) are in all the moment and are not modeling in this case, but must be considered.
- Since all LMS offer a variety of users, this work use the teacher user or equivalent.

A. Creating the map of knowledge for each LMS

Below are showing very generic global maps of each LMS to ascertain their generic structure, it is clarified that this article are not show all maps, because it is a job too many long and not is the purpose. the work is identify the modules of LMS based on acquired knowledge and experience, of having worked with each, finally determine the common modules between the LMS studied.

1) Knowledge map for Atutor

Atutor mainly used PHP for the development, the assembly for testing was done with a Apache Web server, PHP and a database engine MySQL, the browser used for testing was Firefox3.

ATutor offers a page that contains the next modules: My Courses, Browse courses, Profile, Preferences, Networking, Inbox, Find and Help. These modules in turn lead to others modules, the main view of the map can be displayed in Figure 3.

The ATutor modules obtained are shown in Table 4, which shows the hierarchy tree of each module.
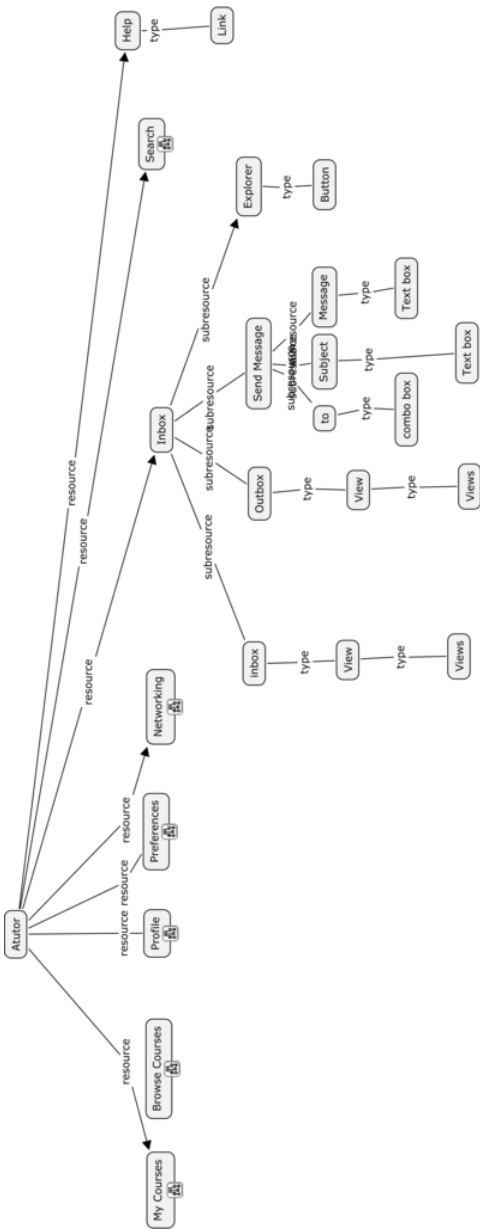
Figure 10 Initial knowledge map of Atutor, Source Author.

Atutor – Level 0	Level 1	Level 2	Level 3
My courses			
	Course		
		My tests and surveys	
		Directory	
			Groups
		Forums	
		Networking	
			Photo Gallery
		Site Map	
		Photo Gallery	
		Student Tools	
			Glossary
			Content Explorer

			Chat
			Links
			Forums
			Quiz
			FAQ
			Groups
			Reading list
			File Storage
			Test and task
			Photo Gallery
			Directory
			Search in repository
			Site map
			My Monitoring
		Administrator	
			File Administrator
			Announcements
			Chat
			Contents
			Backup
			Quiz
			Email Course
			Statistics
			Test and Quiz
			Forums
			Glossary
			Groups
			Course tools
			Student tools
			Registration
			Reading list
			FAQ
			Properties
			Test and task
			Tasks
	Course creation		
Browse Courses			
Profile			
Preferences			
Networking			
Inbox			
Search			
Help			

Table 6 Atutor modules, Source Author.

2) Knowledge map for Claroline

   Claroline mainly used PHP for the development, assembly for testing was done with a Apache Web server, PHP and a database engine MySQL, the browser used for testing was Firefox3.

Claroline, shows at the beginning a page that contains the modules of: Evaluation system, Calendar, Homepage of the

course, Course description, Announcements, Documents, Exercises, Learning Path, Jobs, Forums, Groups, Wiki, Discussionand and Users, the main view of the map can be visualized in Figure 4.
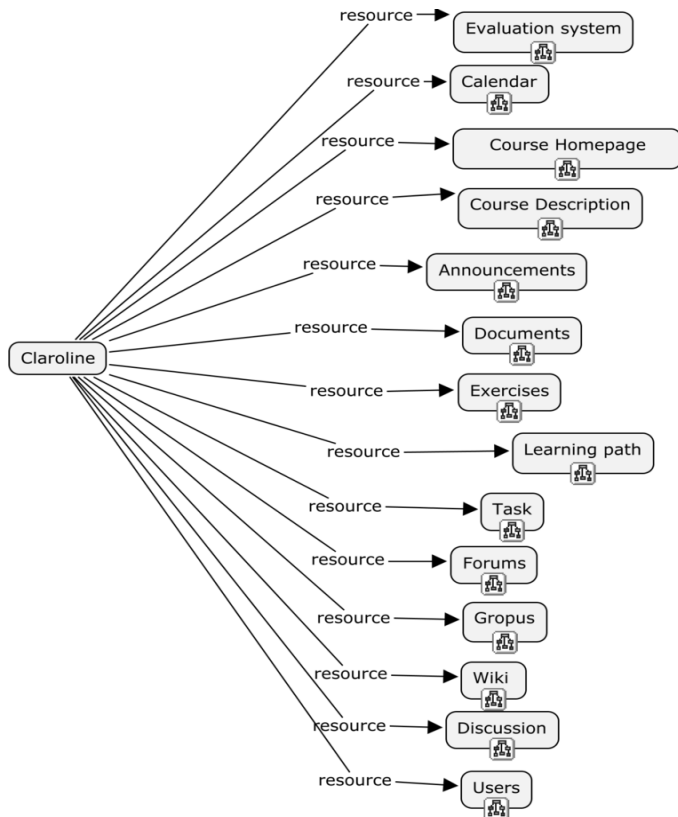

Figure 11 Initial knowledge map of Claroline, Source Author.

The Claroline modules obtained are shown in Table 5, which shows the hierarchy tree of each module.

Claroline Level 0
Evaluation System
Calendar
Course Homepage
Course Description
Announcements
Documents
Exercises
Learning path
Task
Forums
Groups
Wiki
Discussion
Users

Table 7 Claroline modules, Source Author.

3) Knowledge map for Moodle

Moodle mainly used PHP for the development, assembly for testing was done with a Apache Web server, PHP and a database engine MySQL, the browser used for testing was Firefox3.

Moodle, shows at the beginning a page that contains the modules of:categories of courses, online users and site administration, the main view of the map can be visualized in Figure 5.

Figure 12 Initial knowledge map of Moodle, Source Author.

The Moodle modules obtained are shown in Table 6, which shows the hierarchy tree of each module.

Moodle Level 0	Level 1	Level 2
Home		
	Add resources	
		Insert Tag
		Compose a text page
		Compose a Web page
		Files or Web link
		Deploying IMS Content Package
	Add activity	
		Data Base
		Chat
		Browse
		Questions
		Quiz
		Forums
		Glossary
		Topic
		Scorm
		Advanced File Uploading
		Upload File
		Activity offline
		Wiki
		Course Categories
		Online Users
		Administration

	Courses categories	
	Online Users	
	Site Administration	

<div align="center">Table 8 Moodle modules, Source Author</div>

4) Knowledge map for DotRLN

DotRLN, used a database engine PostgreSQL, a Web AOL Server (American On Line), upper this is mounted Open ACS (Architecture Community System), this is the heart that offers funtions to upper layers and finally above all is LRN, the operating system is Ubuntu server, the

the browser used for testing was Firefox3.

DotRLN, shows at the beginning a page that contains the modules of: Home, Professional, Community and Control Panel, the main view of the map can be visualized in Figure 6.
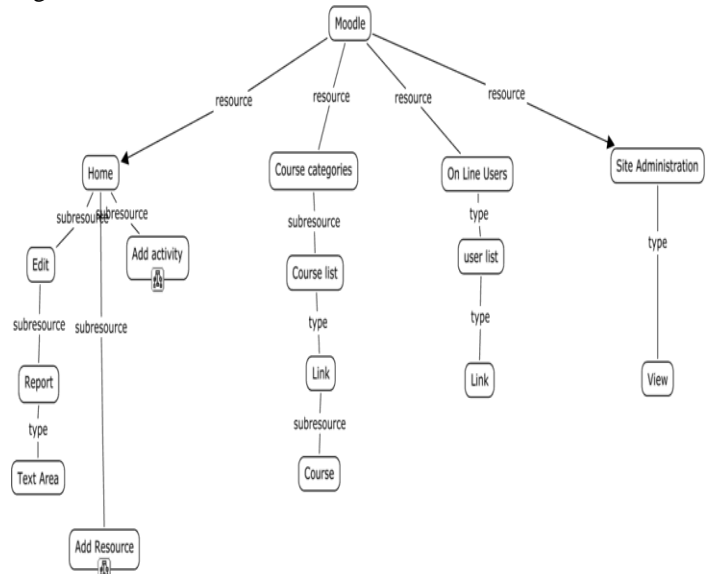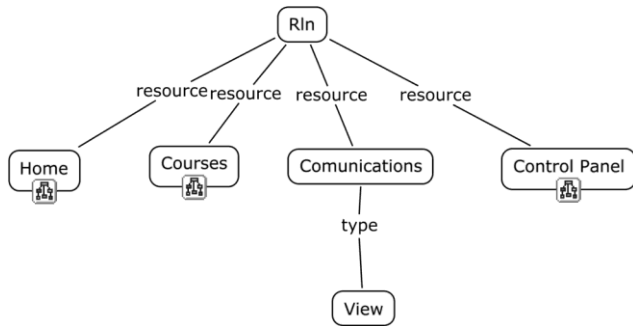

Figure 13 Initial knowledge map of DotRLN, Source Author.

The DotRLN modules obtained are shown in Table 7, which shows the hierarchy tree of each module.

RLN Level 0	Level 1	Level 2	Level 3	Level 5	Level 6
Home					
	My portal				
		Groups			
			Curses		
				Forums	
				FAQ	
				News	
				Course information	
				Learning Content	
				Teachers	
				Subgroups	
				Schedules	
				Calendar	
				Tasks	
				Quiz	
				Chat	
				Weblogger	
			Calendar		
			Documents		
			Class material		
				Assignments	
					Tasks
					Projects
					Test
				Evaluations	
					Manage my allowance rates
					Request notifications
					Tasks
					Projects
					Test
			Administration		
				Groups Administration	
				Forums Administration	
				FAQ Administration	
				Portlets Administration	
				Tasks Administration	
				Evaluations Administration	
				Chat Administrator	
				Xowiki Portlet Administration	
				Documents Administration	
				Calendar Administration	
				News administration	
				Mail Service	
				Quiz Administration	
				Learning Content Administration	

				Weblogger Administration	
		Forum			
		FAQ			
		News			
		Calendar			
		Quiz			
		Chat			
		Weblogger			
	My calendar				
	My documents				
		Documents			
Courses					
Communities					
Control Panel					
	My account				
	Photo				
	Privacy				
	Help				

Table 9 DotRLN modules, Source Author

5) Knowledge map for Sakai

Sakai is Java based. by this Sakai is multiplatform, for its functioning is recommended to install java SE 6, Apache Tomcat (Version 5.5.30) as servlet container, the database engine MySQL 5.1 and the driver of connection to the database data, the browser used for testing was Firefox3.

Sakai, shows at the beginning a page that contains the modules of: Home, My communications, My tools with Resources, Portfolios, News, Web content, Search, and Evaluation System, y My settings with Profile2, Membership, Preferences, Account and Site setup, the main view of the map can be visualized in Figure 7.
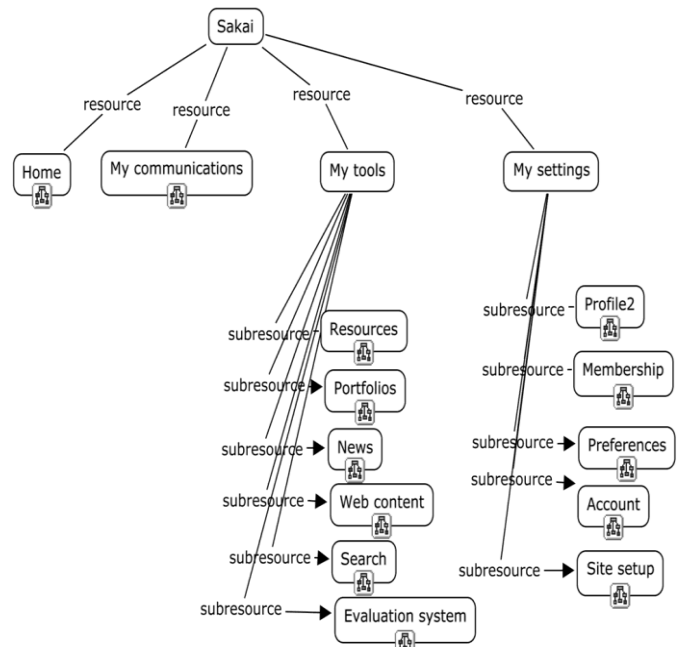

Figure 14 Initial knowledge map of Sakai, Source Author.

The Sakai modules obtained are shown in Table 8, which shows the hierarchy tree of each module.

Sakai Level 0	Level 1
Home	
	Menssage of the day
	My workspace information
	Recent announcements
	Calendar
	Message y forums notification
My communications	
	Calendar
	Announcements
	Help
My tools	
	Resources
	Portfolios
	News
	Web content
	Search
	Evaluation system
My settings	
	Profile2
	Membership
	Preferences
	Account
	Site setup

Table 10 Sakai modules, Source Author

VII. COMPARISON BETWEEN THE LMS MODULES WORKED.

Taken as a starting point the modules each LMS and based on experience I provide for having working each in

mode teacher, was made a comparison process between the modules of the LMS's, and finally generating Table 8 , which shows a first approximation of potential modules compatible into LMS's and a generic name for them.

Comparison Modules LMS					
Generic	**Atutor**	**Claroline**	**Moodle**	**RLN**	**Sakai**
File manager	File Administrator	Documents	Add resources	Documents	Resources
Announcement	Announcements	Announcements	Home		Announcement
Help	Help	Help	Help	Help	Help
Chat	Chat		Chat	Chat	
Management Curricula	Contents		Add resource	Class material	Resources
			Add activity	Learning contents	
Educational Design	Administration	Learning path	Site Administration	Control panel	Portfolios
					Preferences
Course	Course	Course claroline	Module	Curse	Portfolios
Authentication	Directory	Users	Users	Teachers	Accounts
Survey	Quiz		Quiz		
Evaluation System	Tests and Quiz	Evaluation System	Questions	Evaluations	Evaluation System
				Questions	
Forums	Forums	Forums	Forums	Forums	Messages and Forums
Glossary	Glossary		Glossary		
Groups	Groups	Groups		Groups	
Work Group	Networking			Communities	Profile2
FAQ	FAQ			FAQ	
Activity calendar		calendar	Activities	My calendar	Calendar
News				News	News
Wiki		Wiki	Wiki		
Rating system	Test and task	Exercises	Module	Evaluates	Event
		Task	Advanced File Uploading	Test	
			Upload File	Projects	
				Task	
Administration	Preference	Yes	Site Administration	Control Panel	Membership (Site administration)
Comparison Modules LMS					

Table 11 Comparison modules LMS, Source Author

The table 9 displays the generic modules File Management, Help, Management Course, Courses, Users, Systems evaluation, Forums, Jobs and Platform

Management, in a first comparative exist in all LMS's.

VIII. CONCLUSIONS

All LMS's have a similar core, this is the management of courses and activities treated there, and somehow these activities are associated with a calendar.

All LMS's have differents users but essentially have three that are the platform administrator, teacher and student. is very important to clarify that the teacher should not be responsible for managing the platform, your mission in the LMS is managing your course, these tasks are often confused.

All Platforms work with internet orientation, have a database for storage, and a web server to be deployed.

As much as there is some similarity between the modules of LMS's platforms, each of the LMS's implemented and managed in a particular your module, for example the module of user or forums. This implies that modules are different between platforms.

This work is the foundation and gives free rein to the possibility of constructing ontology for modeling courses based a standard.

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