

INTELLIGENT SYSTEM FOR EVALUATING E-LEARNING PLATFORMS

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Abstract: The major consequence of Internet using has been the rapid growth of technology mediated distance learning at each level of education. Open-source e-learning platforms, like course management systems, learning management systems or learning content management systems have lately become an obvious choice whenever an e-learning infrastructure is being designed. Due to the diversity of these platforms with many characteristics and to the constraints of an educational institution or even enterprise, the task of choosing a suitable platform that meets particular requirements is not trivial. The main purpose of this paper is to present an intelligent system (an expert system) supporting this decision-making. The knowledge base contains facts regarding characteristics of some open-source e-learning platforms (ATutor, LON-CAPA, Moodle, DotLRN/OpenACS, Sakai, Claroline and Docebo) and rules for reasoning about decision-making. CLIPS language is used for building the knowledge base for the intelligent system and C# language for the graphical user interface.

Keywords: e-learning platforms, comparative study, platforms evaluation, artificial intelligence, knowledge based system, expert system

1. INTRODUCTION

Rapid changes, improvements and innovations in technology are bringing down the walls of the traditional classroom. Special environments enable teachers to extend the classroom beyond its traditional boundaries of time and space and can be used to supplement a conventional course experience. The “online learning”, “distance learning” and “e-learning” become an integral part of our education and a way of life.

The great success of the distance learning paradigm has also led to the development of a great number learning environments (commercial or open-source) with more or less different features and, implicitly, with its strengths and weaknesses. Due to the diversity of these platforms with many features and, on the other hand, to the constraints of educational institutions or even enterprises, the task of choosing a suitable platform that meets particular requirements

is not trivial. A such e-learning platform should be adopted by a teacher, educational institution or even a company only after a carefully evaluating process.

The aim of this study is to make an inventory of the options or alternative available to those who are looking to acquire a technology enhanced learning platform. Based on this comparative study, a software tool, an intelligent system for decision making is proposed. This system will support the user to choose the more suitable platform.

The paper is structured as follows: section II provides some term definitions and a short presentation of learning platforms, section III presents the categories covering principal features of these platforms, section IV presents the design and the implementation of the proposed support tool (the intelligent system), section V presents results and discussions. The last section concerns conclusions and future works.

2. DIVERSITY OF E-LEARNING PLATFORMS

E-learning platforms - systems based on Information and Communication Technologies (ICTs) - enable teachers to supplement/organize a conventional course experience, from authoring different instructional resources to communicate and/or work together with their students (Stefanescu, 2015).

The term Learning Platform (LP) describes a broad variety of systems used in an instructional process to support learning and to deliver multimedia content, where hardware, software and supporting services work together to allow more powerful methods of instruction.

A Content Management System (CMS) provides the means to organize, control and publish of a large body of documents and other content. The aim of such a system is to make the content available, to share files or to transfer electronic documents for approval or storage (the last one, especially inside a company or between companies) (Open-source Scripts List & Software Directory, 2022).

A Learning Management System (LMS) is a software tool focused on management of learner interventions and communications. A such system provides a personalized online learning space for the learner and so, a high-level solution for managing, delivering, and planning the learning events within an organization; this may include online, virtual classrooms and instructor-led courses. A LMS keeps track of learner performance and progress during the instructional activities (Medved, 2015).

A Learning Content Management System (LCMS) is a further development of the LMS; but, in contrast with a LMS, the focus of a LCMS is on the learning content. Usually, such a system provides to learning developers a multi-user environment where they can manage (create, store, reuse and deliver) digital instructional content by accessing a central learning object repository.

A Course Management System (CMS) is a web-based software that provides to the instructor a framework for the management of the online learning content (courses, tests and quizzes), the management of students (registration, enrollment), the tracking of student performances), the management of access rights and interactions/ communications with students (chat, threaded discussions, e-mail, et al.).

3. COMPARATIVE STUDY OF OPEN-SOURCE E-LEARNING PLATFORMS

Many learning platforms are now available for implementation and use. For our evaluation process of e-learning platforms the study of

characteristics/features of them is mandatory, as a starting point.

Numerous sites (Open-source Scripts List & Software Directory, 2022), (Medved, 2015) and articles (Riddell, 2022), (Learning Management System Software - Top Features Comparison and Guide, 2019) provide reviews of learning platforms characteristics, mostly concentrated in comparative study of their features, based on human experts' evaluation (Stefanescu, et al, 2007), (Amalou, 2016), (Ouadoud, et al, 2019), (Al-Ajlan, et al, 2016), (Fernandes, et al, 2014), (Cavus, 2014).

Our study focused only on free and open-source LPs. The first step was to choose 30 well-known learning environments and documented open-source learning environments. From these, for evaluation, we have selected a group of seven LPs designed for the same goal and needs: Learning Content Management Systems and Course Management Systems. Based on the selection criteria (focus on active community, stable development status, and good documentation of the platform), seven software platforms were agreed: Atutor (ATutor Learning Management System, 2022), LON-CAPA (LON-CAPA - Open-Source Free CMS/LCMS, 2022), OpenACS/dotLRN (OpenACS, 2022), (dotLRN User documentation, 2022), Moodle (Moodle Features, 2022), Sakai (SAKAI - Feature Details, 2022), Claroline (Claroline, 2022), and Dokeos (Dokeos LMS, 2022).

For evaluating, we have selected the most important criteria to compare and we have established three categories of characteristics: technical specifications, tools for learners and tools for instructors. These categories include several subcategories containing the evaluated features.

The category Technical Specifications includes features related to five technical requirements (operating system, web server, application server, databases, programming languages). Table I presents the technical requirements for the selected platforms and information regarding the latest release.

The category Tools for Learners includes three subcategories: Tools for communication (with 5 features), Tools for productivity (5 features), and Tools for student involvement (4 features).

The category Tools for Instructors includes three subcategories: Tools for administration (4 features), Tools for course delivery (6 features), and Tools for content development (6 features).

All these considered features are evaluated by the CMS Community of Practice (CMSmatrix, 2022) and each feature could exist or not; associated values are y (yes, if exists), and n (no, if doesn't exist). Table 2 presents the values for each considered feature.

Table 1. Technical specifications for the considered learning platforms.

No	Learning Platform's Name	Latest release	Latest release date	Technical Requirements				
				Operating System	Web Server	Application Server	Databases	Programming Languages
1.	Atutor	2.2.4	June, 2018	linux, MAC	Apache	PHP	MySQL	PHP, JavaScript
2.	LON-CAPA	2.5.2		linux, unix, mac, windows	Apache	PHP	MySQL	JavaScript, perl
3.	OpenACS/dotLRN	5.9.2/2.9.1	2020	unix, windows, FreeBSD	linux, MAC, AOL	Apache	PostgreSQL, Oracle	Tcl, XOTcl
4.	Moodle	3.9+	June, 2020	any	any	PHP	MySQL, Oracle, PostgreSQL, MariaDB, MSSQL	PHP
5.	Sakai	20.0	April, 2020	unix, windows	Apache	Tomcat	MySQL, Oracle	Java
6.	Claroline	1.11.10	Nov., 2015	linux	Apache	Apache	MySQL	PHP
		1.12	Soon					
7.	Dokeos	2.1.1	Jan., 2012	linux, MAC	Apache	Apache	MySQL	PHP, Javascript, XML, XHTML

Table 2. Features values – Tools for learners and tools for instructors categories.

Features			Features Values						
Category	Subcategories	Feature Name	ATutor	LON-CAPA	openACS/dotLRN	Moodle	Sakai	Claroline	Dokeos
Tools for Learners	Communication Tools	Discussion forums	y	y	y	y	y	y	y
		File exchange / Internal email	y	y	y	y	y	y	y
		Online journal / Notes	n	n	n	y	y	y	y
		Real-time chat	y	y	y	y	y	y	y
		Video services / Whiteboard	n	n	n	y	n	n	n
	Productivity Tools	Bookmarks	n	y	y	y	y	n	y
		Orientation / Help	y	y	n	y	y	y	y
		Searching within course	y	y	y	y	y	y	y
		Calendar / Progress review	y	y	y	y	y	y	y
		Work offline / Synchronize	y	y	n	y	y	y	y
	Student Involvement Tools	Groupworks	y	y	y	y	y	y	y
		Self-assessment	y	y	y	y	y	y	y
		Student community building	y	n	y	y	y	y	y
Student portfolios		n	y	y	y	y	y	y	
Tools for Instructors	Administration Tools	Authentication	y	y	y	y	y	y	y
		Course authorization	y	y	y	y	y	y	y
		Hosted service	y	y	y	y	y	y	y
		Registration integration	y	y	y	y	y	y	y
	Course Delivery Tools	Test types	y	y	y	y	y	y	y
		Automated test management	y	y	y	y	y	y	n
		Automated testing support	y	y	y	y	y	y	y
		Course management	y	y	y	y	y	y	y
		Online grading tools	y	y	y	y	y	y	y
		Student tracking	y	y	y	y	y	y	y

Features			Features Values						
Category	Subcategories	Feature Name	ATutor	LON-CAPA	openACS/dotLRN	Moodle	Sakai	Claroline	Dokeys
		Accessibility Compliance	y	y	y	y	y	y	y
		Content sharing/Reuse	y	y	y	y	y	y	y
	Content Delevopment Tools	Course templates	y	y	y	y	y	y	y
		Customized Look & Feel	y	y	y	y	y	y	y
		Instructional design	y	y	y	y	y	y	y
		Instructional standard compliance	y	y	y	y	y	y	y

The summary of choosen categories and features from this study can be compared especially by Al-Ajlan (Al-Ajlan, 2016).

Usually, the results of existing evaluations were done by a manual processing or using Microsoft Excel application (Momani, 2015). Our study is an attempt to step forward, through designing and implementing of this intelligent support system for choosing a LP that meets particular requirements.

We have found only few “classical”, web-based systems for LP evaluation (CMSmatrix, 2022), (Software Advice, 2022), (GetApp, 2022), (LMS Software, 2022) and two intelligent systems.

In (Pecheanu, et al, 2011) the authors present an evaluation method based on Formal Concept Analysis (FCA), a method belonging to the Artificial Intelligence. By using the Lattice Miner software, the classification process has been carried out for each subcategory of features of the whole group of learning platforms.

The second one (Cavus, 2010) is a fuzzy logic based evaluation method applied in an intelligent system for choosing a LP (Momani, 2015).

4. INTELLIGENT SYSTEM DESIGN AND IMPLEMENTATION

The proposed system, named ExpS_ELearningPlatforms, uses artificial intelligence techniques which provides human like behavior in problem-solving processes to LP evaluation, in order to support the users to choose the convenient LP depending on their needs and their usage.

The first prototype of the system was the one with a simple, interactive and text-oriented interface; The second prototype, presented in this paper, has a graphical user interface.

The expert system for the both prototypes was implemented in CLIPS (C Language Integrated Production System) (CLIPS - A Tool for Building Expert Systems, 2022), CLIPS - Reference Manual

2022); the graphical user interface for the second prototype was developed in C# language, using Microsoft Visual Studio.

From the left side of the application window (Fig. 1) the user can select interested features (even only one or more groups of features). By clicking on the DONE button, the results – a list of LMSs - will be displayed in the right side of the window. By selecting a specific item (LMS name) from the results list, the logo platform and info details will be displayed below. If none LP with required features was found (Fig. 2), the system will recommend some LPs with similar features (Fig. 3).

To develop the expert system, we have used CLIPS, a “tool developed by the Software Technology Branch (STB), NASA/Lyndon B. Johnson Space Center. Since its first release in 1986, CLIPS has undergone continual refinement and improvement.” (Giarratano, 2022).

The knowledge base (KB) contains:

- Facts regarding the characteristics/features of some open e-learning platforms: deftemplate construct creates the template PlatformaELearning, with slots single-slot and multi-slot, used by non-ordered facts, and deffacts construct defines the list of facts (LPs and features) which are automatically asserted whenever the reset command is performed.
- Rules intended for euristic knowledge (defined by defrule construct).
- Functions for representing procedural knowledge (deffunction construct).

A rule is similar to an IF THEN statement in a procedural language, a collection of conditions and the actions to be taken if the conditions are met.

The inference engine of CLIPS applies a forward chaining strategy, based on the Rete algorithm which enables a very efficient pattern matching (CLIPS – Advanced Programming Guide, Volume II, 2022). The inference engine attempts to match the rules to the current state of the system (as represented by the fact-list and instance-list) and applies the actions.

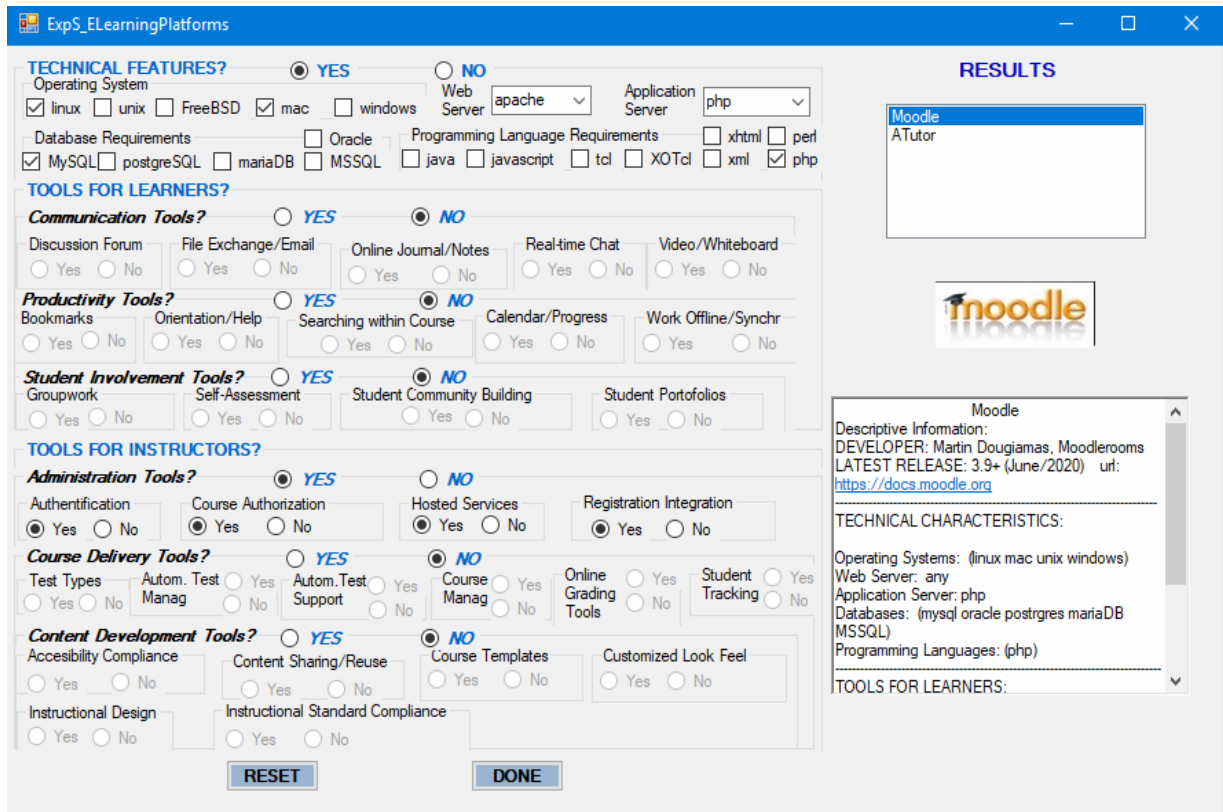


Fig. 1. ExpS-ELearningPlatforms - The main application window

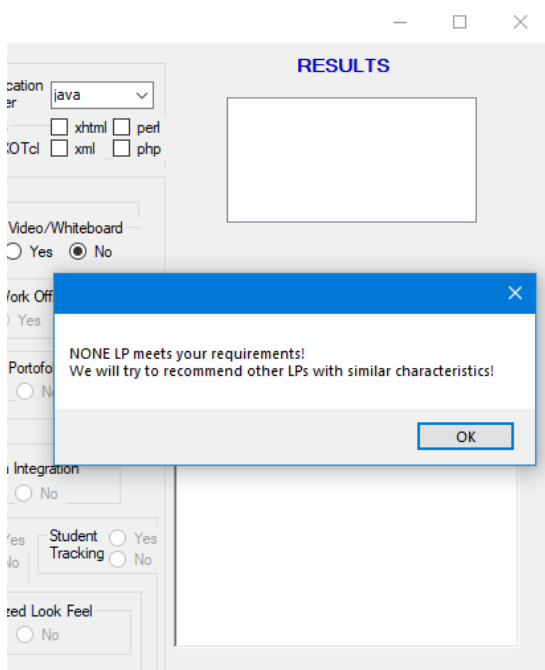


Fig. 2. Results and message (none perfect match for required features)

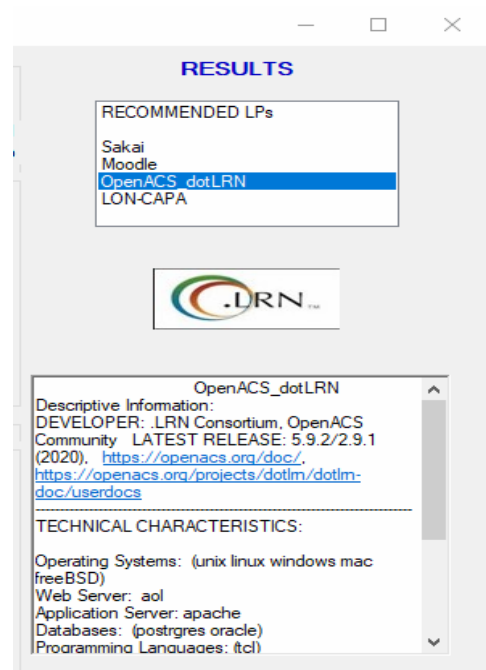


Fig. 3. Results – Recommended LPs

The mechanism used for ordering the execution of rules is salience.

The conflict resolution strategy used in this system is the depth strategy: new rule activations are placed on the agenda after activations with higher salience, but before activations with equal or lower salience; so, the agenda is ordered from highest to lowest salience.

The knowledge base for the first prototype (with text based interface) contains 45 rules and 2 functions used for validation of user answers.

The knowledge base for the second prototype (with graphical user interface) contains 20 rules.

In the case where a perfect match between the characteristics that a potential user might require and the LP features can't be found, the rules used for recommendation are:

- From the technical features, operating system is the most important feature. So, if there aren't perfect match (for example, the user selects linux and mac) the system will recommend also the LPs with "only linux" or "only mac".
- For other selected categories/subcategory (marked "yes"/"no"), the system will recommend the LPs with the greatest number of matched features from the selected subcategory.

For the second prototype, developed in Microsoft Visual Studio 2019, to make calls to Clips from C#, we have added to the created project the reference to the file ClipsWrapper.dll (a wrapper written using .NET, compiled into DLL).

5. RESULTS AND DISCUSSIONS

We proceeded with our study and we've found the following results:

For the category Tools for Learners:

- For the subcategory Communication Tools, with 5 features, only Moodle has all features; Sakai, Claroline and Dokeos have 4 features, and ATutor, LON-CAPA and OpenACS_dotLRN have only 3.
- For the subcategory Productivity Tools, with 5 features, 5 LPs (LON-CAPA, Moodle, Sakai, Claroline and Dokeos) have all features; ATutor has 4 features and OpenACS_dotLRN has only 3.
- For the subcategory Student Involvement Tools 5 LPs have all the features; ATutor and LON-CAPA have 4 features.

For the category Tools for Instructors:

- For the subcategory Administration Tools, with 4 features, all LPs have all these features.
- For the subcategory Course Delivery Tools, with 6 features, 5 LPs have all features, and Dokeos has only 4.
- For the subcategory Content Development Tools, with 6 features, five LPs have all features, and Claroline and Dokeos have only 5.

6. CONCLUSIONS AND FUTURE WORKS

In this paper we have presented an intelligent system for evaluating e-learning platforms. The individuals who are most likely to be interested in this evaluation process are researchers, teachers, students, educational organizations (universities, schools, institutes), and anyone else who seeks to have a such LP. The right platform is related with the characteristics that a potential user might require.

This system is among the first intelligent systems developed for this purpose and clearly demonstrates the utility of the evaluation application as an able aide for effective choosing an e-learning platform.

The future directions for the system development are the enrichment of the knowledge base with new facts and new rules, the extension with a database, the knowledge acquisition automation and adding the web-based accessibility to make it easier to access from different geographical locations.

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