STUDY ON OPEN SOURCE LEARNING MANAGEMENT SYSTEMS: A SURVEY, PROFILE, AND TAXONOMY

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ABSTRACT

Open Source Software (OSS) in the education field has often been recommended by different researchers in literature. Despite the fact that there has not been evidence, yet, of current OSS dominance over traditional methods, OSS use in education has been steadily increasing and expanding covering new domains. The reputation of the OSS learning system has a great deal of importance when it comes to people interested in adopting a Learning Management System (LMS). At any rate, choosing to start a new application or adapt and modify an existing one is an important decision. The study aims to produce basic guidance towards available OSS LMS, and their substitutes in the field of education. 23 different alternatives were picked from the existing active OSS based on previously published papers, the study also aims to produce a summary of the available studies and guides available, finally the study is aiming to bridge the gaps in the current literature while proposing a taxonomy of OSS LMS in 56 papers taken from literature.

Keywords: *Open source software, Learning Management System, Evaluation, Adoption*

1. INTRODUCTION

After the boom of the internet and internet-based technologies, educational bodies started to invest heavily in electronic learning systems (e-learning) to better support their teaching capabilities over long distances. Learning Management System (LMS) is one such system that has the ability to distribute courses using the internet. The system has many advantages, namely: it aids tutor-to-student communication, it helps track students' progress, and guarantees secured information exchange over the internet [1].

A decent amount of LMS have been developed using Open Source Software(OSS) licenses, examples are aTutor, Claroline, and Moodle amongst many other that are currently active in e-learning. [2]. There are many pros of OSS, it's basically free of any licensing fees, it is also delivered with its own source code for computer programming. These pros covers the short-comings of traditional learning system as it eliminates campus-wide software applications cost, at the same time it enables creating learner-centered systems [3].

This study aims to provide a more comprehensive guide to the available different OSS LMS systems, specifically in the educational field. The rest of the paper is organized as follows. The second section contains a background on OSS, Followed by an explanation of the research methodology in section three. Section 4 has a list with the active OSS LMS. The proposed taxonomy is presented in chapter 5. Finally, the discussion of and the conclusion are presented.

2. BACKGROUND
2.1. Learning Platform

The word of Learning Platform (LP) describes a wide range of ICT systems employed to deliver and help the learning process. Through a LP, software, hardware and services are brought together to

provide more effective methods of working inside and outside the classroom. With the center of any LP is the idea of some sort of personalized learning space that ought to provide users access to stored learning sources. The LP really should provide communication, collaboration and track users' progress within learning [4].

A particular software called the Learning Management System (LMS) is mostly used in institutions that depend on web-based learning. With this system, tutors and students do not need to be physically present in the same location. Education can happen at any place that has a computer and an Internet connection, which may be in homes, Internet cafes, and workplaces [5].

An LMS is an information system that supports e-learning environment. It is used to store and publish educational materials and support the administration and communication of teaching and learning. LMSs are usually implemented in a university, institution, or school to support student learning and course management [6].

Lying on the borders of education and e-learning depends on several aspects of IT, essentially managed by software. It is this component (the software) that we target to discover in this paper, for which many open source alternatives are already available, and deemed to have the potential to play a key role in applying e-learning to education, as alternatives to the existent proprietary systems.

2.2. Open Source Software

Richard M. Stallman founded free open source software in the mid of 1980, the institute they founded considered free software a must have for anyone in the world. It has three characteristics, they are: using, altering, and transferring of the source codes [1].

Open Source Initiative defines OSS in terms of its use and distribution, they mentioned ten distinct features of an open source license, it includes the source code distributed with the product, free distribution, deriving the work from the code, preserving original author's contribution integrity, it must not be prejudice against any persons or group[2], [3].

In contrast with public domains, copyright and license agreement is essential to keep the software open. Open source LMS have many benefits, they are; universal access at a lower cost usually associated with licensing, affordability to

individuals and enterprises amongst the government and private sectors, customizability to local languages, and participation in the global network by providing necessary developmental tools to software [4], [5]. Furthermore, the Free Software Foundation agreement requires any software developed using the licensed software to be Open Source. On the other hand, there is another more flexible agreement called the BSD agreement founded by the Apache foundation. The agreement allows software retailers to embed the open-source software in their products without losing their rights to the open-source software they are developing upon [6]. Originally, this was called free software, however, the inception of the term "Open Source" was necessary to avoid confusion with the literal meaning of the word "free" in the English language. Nevertheless, Free/Open source software was a term coined to describe a combination of both the meanings[7]. This development paved the way to save a lot of resources available dedicated to licensing, in institutional settings and governmental bodies, this could prove effective [8].

3. METHODOLOGY
3.1. Conceptual Framework

The design of this study depends on the current and active OSS in the educational field. The purpose of this study is to provide a summary of available guides and studies related to OSS, and the second purpose is to bridge any gaps in literature regarding OSS systems applications. Results driven from the literature includes a categorization of the articles reviewed. The paper does that to make the array of published papers on OSS LMS more obvious, with a brief description of each surveyed paper. The conceptual framework illustrates in Figure 1.
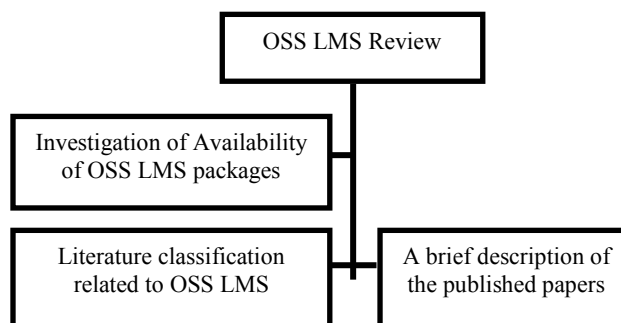

Figure 1 – Conceptual Framework Of The Design And Contribution For This Paper

3.2. Scope

The scope of study and review is respect to the term OSS LMS, the work in this paper applies only to the OSS LMS that related to our search engine databases and term that mentioned in the literature review next section.

3.3. Literature Review Method

The research was initiated in the first quarter of 2014, it began with several databases, it included ACM portal, IEEE Xplore, ScienceDirect, and Web of Science. Keywords used in the search included 'open source software' and 'learning management system', or 'open source software' and 'e-learning system' among others. Using inclusion criteria, a scope was determined to include 55 papers after a thorough filtering process according to relevance.

4. THE ACTIVE LIST OF OSS LMS IN LITERATURE

LMS are defined as software dedicated to the administration, tracking, and reporting of e-learning processes[9]. This section includes the reviews carried out of previously published papers which are more relevant to open source learning management systems. Few papers presented a case study using these systems; other papers used experimental and comparative studies. The goal of this review is to recognize and collect data on these systems, the ones who adopted the systems, a comprehensive list of OSS LMS systems as collected from the papers reviewed.

Table 1 List Of OSS LMS That Collected From Published Papers

OSS LMS	References
aTutor	[10] [11] [12] [13] [14] [15] [16] [17] [18] [19]
Bazaar LMS	[18]
Bodington	[20] [16]
Canvas	[21]
Chamilo	[22]
Claroline	[10] [12] [20] [23] [15] [16] [24] [25] [17] [18] [26] [19]
Dokeos	[11] [20] [14] [15] [16] [24] [26] [19]
eFront	[27]
Ganesha LMS	[18]
ILIAS	[11] [12] [16] [25] [17] [18] [19]
KEWL	[28] [16] [29] [18] [26]
LearnSquare	[30]
.LRN	[9] [31] [11] [32] [12] [33] [34] [16] [35] [36] [17] [18] [19]
LogiCampus	[16]
LON-CAPA	[11] [16] [18] [19]
Moodle	[9] [10] [1] [37] [38] [11] [32] [12] [39] [20] [40] [41] [42] [43] [14] [44] [23] [45] [15] [46] [47] [34] [48] [49] [16] [35] [24] [50] [51] [36] [52] [53] [25] [17] [54] [18] [55] [26] [19, 56, 57]
OLAT	[12] [20] [42] [14] [15] [49] [58] [26] [19]
OPAL	[59]
OpenUSS	[11]
Sakai	[9] [38] [11] [32] [12] [20] [60] [43] [61] [34] [48] [16] [35] [24] [36] [17] [54] [26] [19, 56]
Spaghetti learning	[11] [18]
Totara LMS	[20]
WeBWorK	[62] [18]

Table 1 presents the frequency of references for OSS LMS. Firstly, it can be observed that the Moodle system is the most commonly used one, representing 40 papers out of 56. The Sakai system came in second, according to the amount of references in literature.

Dot LRN, Claroline, and aTutor systems were fairly equally between number of references. Dokeos, OLAT and LON-CAPA systems were much less mentioned than Moodle system,. WeBWork, Spaghetti learning, and Bodington systems mentioned on two papers. Finally the least quantity of papers represented by Totara LMS, OpenUSS, OPAL, LearnSquare, LogiCampus, Ganesha LMS, eFront, Chamilo, Canvas and Bazaar LMS systems. From the above results, we can conclude that Moodle system is the most studied by authors .

Table 2 have lists of OSS LMS, this list is constituted of 23 OSS LMS with their websites mentioned accordingly, a brief description to assist decision makers in the evaluation process of OSS LMS.

Table 2 Summary Of OSS LMS Packages

OSS LMS		Brief Description
aTutor	About	aTutor is a web-based open source LMS designed with adaptability and accessibility in mind. The administrators can install or update the system in minutes, also can custom templates to give it a new look, and can easily extend the functionality with feature modules.
	Website	http://www.atutor.ca/

Name	Field	Description
Bazaar LMS	About	Bazaar is a web-based content hosting platform, the LMS designed with users and administration in mind. The system is available to the education community as an OSS alternative to such proprietary and expensive commercial systems.
	Website	https://www.openhub.net/p/5085
Bodington	About	Bodington is a free OSS LMS in use at colleges and universities worldwide. Bodington is used to support teaching, learning and researching across a range of learning institutions.
	Website	http://elearning-india.com/Learning-Management-System/bodington.html
Canvas	About	Canvas, freely available under an AGPLv3 license as OSS. It is allow the teachers to collaboratively design and transfer the curriculum to a professional e-learning.
	Website	https://github.com/instructure/canvas-lms/wiki
Chamilo	About	Chamilo is project software created in 2001 as free software (OSS) in a radical way. It aims at bringing you the collaboration platform and the best e-learning in the OSS world.
	Website	http://www.chamilo.org/en/about-chamilo
Claroline	About	Claroline is an OSS that easy to use and can deploy a dedicated learning and online collaboration platform easily. As well as available in many languages.
	Website	http://www.claroline.net/type/claroline
Dokeos	About	DOKEOS is an OSS complete LMS, created in 1999 at the University of Louvain; it is a creator solution of e-learning, training providers and multinationals with their online training projects.
	Website	http://www.dokeos.com/
eFront	About	eFront LMS is the best open source solutions at the best of E-learning. It is flexible and powerful, effective and fully functional.
	Website	http://www.efrontlearning.net/
Ganesha LMS	About	Ganesha is a free OSS LMS under license GPL published by Anéma. It is used to handles course administration and e-learning collaborative. Also it is support a several languages: Arabic, English, French, Portuguese and Spanish.
	Website	http://ganesha.fr/index.php?
ILIAS	About	ILIAS is available as OSS LMS under the GNU General Public License. This give full transparency and no license fees. It is a powerful system for teaching and learning. It was the first LMS that used SCORM compliant.
	Website	http://www.ilias.de/
KEWL	About	Knowledge Environment for Web based Learning (KEWL) is a free OSS LMS under the GNU General Public License. It gives comprehensive learning management tool to use in online learning situation.
LearnSquare	Website	http://technologysource.org/article/knowledge_environment_for_webbased_learning_(kewl)/
	About	LearnSquare is a Thai OSS LMS and support the e-learning process. It is compatible with SCORM standard. The learner can learn at your leisure at any time in the media, articles, and pictures, sound and video that can interact with the virtual classroom, which is considered normal for wider educational opportunities.
	Website	http://www.atom.rmutphysics.com/charud/oldnews/0/286/15/6/mechanical/mechanical/index.php-mod=Message&op=aboutus.htm
.LRN	About	.LRN (dot learn) Is a community of educators, designers and software developers who partner together to drive innovation in the field of education. The organizations can save their dollars to develop the people skills and curriculum, because it is free OSS license.
	Website	http://dotlrn.org/
LogiCampus	About	LogiCampus is a free OSS LMS for course management system and distance learning. It provides a single sign-on for students, staff and faculty, and provides more than just a distance learning/ course management system.
	Website	https://www.openhub.net/p/logicampus
LON-CAPA	About	LON-CAPA is free OSS LMS. It supports a full featured learning content management, course management, and assessment system.
	Website	http://www.lon-capa.org/overview.html
Moodle	About	One of the most popular in open source LMSs is Moodle. Moodle is a LMS designed to provide educators, administrators and learners with a single strong, secure and integrated system for learning environments.
	Website	Moodle.org
OLAT	About	Online Learning and Training (OLAT) is an OSS LMS tailored to the needs of Higher Education institutions and Universities. It is provide several languages and diverse functionality for all your needs in education environments.
	Website	http://www.olat.org/
OPAL	About	Online Platform for Academic Learning (OPAL) is the central learning platform of the Saxonian universities. OPAL is technologically based on OLAT. It is OSS LMS and adjusted to the needs of the Saxonian universities.
	Website	https://www.bps-system.de/cms/en/products/opal/
OpenUSS	About	Open Source University Support System (OpenUSS) is an OSS LMS based on ASP model, which used in the universities, schools, and companies. It give users the flexibility to use their chosen appliances.
	Website	http://openuss.sourceforge.net/openuss/index.html

Sakai	About	Sakai is an OSS LMS project provides a flexible and feature-rich environment for teaching, learning, research and other collaboration. It is continually evolves according to the needs of the faculty members, students and organizations.
	Website	https://sakaiproject.org/
Spaghetti learning	About	Spaghetti learning is an OSS LMS written in PHP and used in by many universities around the world. Features: WYSIWYG editor; Cool graphics and layout; Chat and emoticons, Learning Object and File lessons can be stored in logical folders; Statistics; Session time and total time in course.
	Website	http://www.bigwebmaster.com/2130.html
Totara LMS	About	Totara is an OSS LMS, designed to meet the learning management needs of enterprises. It supports several languages: Chinese, English, French, German, Italian, Japanese, Spanish, Portuguese and Polish.
	Website	http://www.totaralms.com/
WeBWorK	About	WeBWorK is an online homework open source system for sciences courses and math. WeBWorK is supported by NSF and MAA and comes with a National Problem Library (NPL) of over 20,000 homework problems. The WeBWorK supports the courses in discrete mathematics, probability and statistics, differential equations, single and multivariable calculus, linear algebra
	Website	http://en.wikipedia.org/wiki/WeBWorK

5. SUBJECT OF OSS LMS IN LITERATURE

A simplified taxonomy was produced using the literature review of the 56 papers. During the filtering process, a pattern appeared, suggesting an initial taxonomy. Different papers discussed OSS applications in the educational fields from different viewpoints. Some authors discussed the software's design and implementation, others discussed the use of statistics in the deployment process and OSS reporting, the learning services associated with it, and the interoperability. For those seeking specific information on particular software, this class of articles could be very useful as it saves them the effort of looking at individual papers for each class of software used in the e-learning environment. This class has 12 papers in the sample this paper uses.

Another class of articles tries to evaluate, not just descriptive, the papers either evaluate the OSS functionality from the educational point, or from an information technology viewpoint. This class contains 27 articles implying the presence of another gap in literature.

At last, 8 papers reviewed advocated the utilization of OSS LMS integrating lab with regular OSS LMS, and the last portion consists of 4 articles describing the adoption of OSS LMS. Figure 2 illustrates the proposed simple literature classification.

5.1. Adoption

The largest UK e-learning provider documents were analyzed qualitatively in order to study their adoption of the Moodle e-learning system. It was shown that the success of their adoption came after a multi-million investment funneled towards the application [51].

Another success story was that of Stoltenkamp and Kasuto who achieved a successful system integration for e-learning between campus teaching communities [29]. An investigation conducted by Van Rooij examined the role of the technical, academical, and institutional profile factors in the decision-making process of an OSS LMS system selection in higher education institutes. The results were also based on previous research that measured patterns of OSS applications the USA. A web survey conducted included 285 CIO (Chief Information Officers) and Chief Academic Officers to determined patterns of OSS LMS deployment and what influenced their decision [63].

A new internal quality features list for adopting and selecting OSS was proposed by Sarrab and Rehman [57], it included three differnet dimensions; system quality, information quality, and service quality. They also used two case studies (OSS network tools, OSS LMS) to apply the features proposed.

5.2. Evaluation

The evaluation process has two different stages, software evaluation, and e-learning evaluation.

5.2.1. Software perspective evaluation

There have been numerous studies in regards of software evaluation, an evaluation criterion was proposed by Graft and List for OSS e-learning systems, the main focus is on the adaptation process and the issues associated with it, as well as that the Moodle system by far out-performs other systems [11]. Another approach was introduced in which a model was developed, the model has multi-attribute decision support to evaluate OSS LMS based on experts' opinions and experience. [64, 65].

The focus on the Moodle platform was also seen in Al-Ajlan, Zedan's comparison, where they

compared between VLE (Moodle) and other VLE systems to find out their advantages and limitations [20]. An analysis was done by Bri and Coll on the existing systems of e-learning, the results were analyzed for the purpose of this research. Based on previous research the paper is going to explore the most popular platforms with details, mentioning their attributes, limitations, and the main differences between them [16].

A comparative analysis was done by Aydin and Tirkes on OSS LMS and the Moodle system. The Moodle system was found to be superb with many desired advantages and features. It was noted that it improves quality of learning, including the quality of the tools used in e-learning [14].

A new method was proposed by Pecheanu for multiple classification criterions, it is based on Formal Concept Analysis using frames. This type of analysis can support the education community to choose an OSS that fits their needs [19].

Iftikhar evaluated e-learning systems' usability; he utilized the process by analyzing requirements for system applications from both users' end. The paper also described a development of software to help in e-learning system adoptions, especially OSS LMS and how to choose the most suitable one [27]. The software is web-based decision support system giving it broad distribution; it is titled Easy Way to Evaluate LMSs [12, 66]. Finally, to determine the optimum requirements for systems evaluation, the authors used a Quality Function Deployment software to help in the decision making process when it comes to information systems evaluation [67].

5.2.2. E-learning perspective evaluation

In the evaluation process of e-learning, several studies rated the importance of LMS typical processes. Quantitative analysis associated with the amount of use and submissions into the management system also correlates with the students' final marks according to Merino, et al. [68]. According to the same source, those results were based on previous surveys about the importance of these features in an e-learning system; a qualitative analysis also confirmed the survey results.

A description of an experience in requirements for OSS LMS tools was analyzed by Paech and Reuschenbach. They stated that the process meets challenges presented in the software selection phase such as crossing the requirements with the needs for a proper e-learning adoption, it also includes a great deal of details in the evaluation, information collection, and service evaluation [69].

Wen and Lin presented an integral information technology study for geographic information. They covered the teaching and learning processes on an electronic environment using the Moodle system, as well as promoting students' achievements interactively[1]. Another analysis conducted on the use of Moodle system reports contained views and posts of 4 different SME's training courses Nagi [70]. The concept pf MILES(Military English Learning System) was introduced by Tick, it dels with software components used in OSS LMS application. Into addition to that, the paper gives thorough details on course development and evaluation chances available. Furthermore, it analyzes the usability and learning habits of the material present to the end users (students) [41].

An approach to describe the mechanism of the implementation was produced by Weinbrenner, et al. [23], the approach produces self-induced assesment in a Moodle envrionent. Another model proposed uses the Moodle system and LMS in institute management. The model examines the reasons and rationale behind the use of the system by different parties. It also includes traditional activities, such as course management, introduced course material , and students' work evaluation [44].

In order to understand how students may behave in an online learning environment, a method was introduced by Ai-Lun. The method uses the Grey relational analysis further understand the issue. It permits predictions of students' grades and activities in said environment, this allows researcher looking to get more insight on students' interactions with the Moodle system [45].

Another method to investigate the extent to which the advantages are valid for an educational institution was presented by Skellas and Ioannidis. It targeted science and technology institutions in primary schools, the goal was to test the usability of a model based on the Moodle system conceived as the best fit for primary school teaching platforms [15].

An investigation was done on whether the Socialization, Externalization, Combination, and Internalization (SECI) model could explain how knowledge creation process happens with demographic factors of online LMS in mind, particularly for postgraduate courses[46, 47].

Rossi and Carletti [58] presented a description of experimentations on OSS LMS with Artificial Intelligence enhancements aimed at supporting online teachers and tutors work. He suggested that using KB specific to educational aspects are not necessarily readily available in mid-level IT environment.

It was found that the average long-term learner motivation was usually lower than expected; this led this research to focus on the factors impacting the learner's motivation to identify the obstacles they might face and that would hinder the potential that lays within the system [49].

A case study on an ongoing pilot for Sakai Abu Dhabi Women's college was done by Hargis, in which he suggests that data regarding the perception of systems were gathered, and then using the means of a couple surveys revealed valuable information used in this research [48].

Rodríguez Ribón, et al. [10] presented inside the cloud, communities make-up a grid of expertise, and that is built while using learning resources that every organization gives you with some other pairs. Currently little is famous about the down sides that steer clear of the formation with the grid of Expertise inside Virtual learning Communities. Such techniques are certainly not being carried out optimally in addition to efficiently. On this paper introduced the description of such problems.

Romero, et al. [55] determined how the choice of instances and characteristics, the usage of different category algorithms and also the date when data is usually collected have an impact on comprehensibility and accuracy of the prediction. The latest Moodle's module intended for collecting online community indicators got its start and various executions were completed using true data by 114 college or university learners throughout a first-year course in computer science.

5.3. System Based Report

A system based reports have five different types; OSS LMS, learning services, experience and usage statistics, implementation and design, and interoperability.

5.3.1. OSS LMS report

LearnSquare system was introduced by Mekpiroon, Tummarattananont, Pravalpruk, Buasroung and Apitiwongmanit [33], the system have three major functions; content management, user management, and system management. Another system was proposed by Arnold and Fisler where it focuses on OSS e-learning management, it's called the OLAT (Online Learning And Training). The OLAT was developed by the University of Zurich in Switzerland. The OLAT is used by different educational institutions to setup and manage their e-learning courses aiding in the collaborative support between students' groups and the educational body [45]. Heller, Englisch, Schneider and Hardt [62] introduced a more efficiency-oriented system, it's called the OPAL. It analyzes user-friendliness, as well as productivity and efficiency. This enables the tutor in course preparation in a dynamic content exchange environment such as the online learning environment.

5.3.2. Learning services

A service-based framework was proposed by Conde, García, Rodríguez-Conde, Alier and García-Holgado [55], it uses interoperability and web services to help the foundation of educational institutions. The framework has been tested in both educational and technical scenarios, producing similar results. The conclusion drawn is that learning platforms can be open and the exportation of functionalities from them to personal contexts can enrich students learning and increase their participation.

5.3.3. Design and implementation

Metadata frameworks' capabilities were examined by Broisin, et al. [37] based on learning technologies as to intersect LMS with Learning Objects Repositories. An identification model was developed by Gil, et al. [31] using biometric technology. The study focused on open source management systems and how to give it more security during course development and distribution, ensuring the safety of the content at the same time. . Hao, et al. [60] on the other hand studied the sakai status at both home and abroad schooling. He analyzed the Sakai's permissibility to put the user account and role remotely via OSS LMS. they also studied the relationships between different factors, namely: sites, roles, users, and permissions. At last, the study gave practical examples on how to develop permissions during the process.

An explanation of shifts in the architecture of the second version of Moodle was done by Alier, et al. [50], as to why those shifts happened and how. He also discussed the modifications that should be applied to the Moodle system to become a true open learning platform instead of a mere learning tool. Finally, Dehnavi and Fard [25] introduced a

new model based on web applications, featuring a new attendance control capabilities. The model they presented was a multimodal biometric model used to identify, authenticate, and track users.

5.3.4. Experience and usage statistics

A brief introduction to e-learning tools was provided by [18], it gave the user some information on each course in the form of a comparison and evaluation. This allows this paper to do the same using both statistical and information analysis of the previous studies. The use of automated real-time reports was also mentioned in previous literature, those reports contain all activities by the user such as views and posts, and get statistical insight and draw conclusions [39].

5.3.5. Interoperability

Several research development projects of varied finance funding sources and locations world-wide were examined; to find a solution to the common problem of providing standards and benchmarks in open learning and e-learning. Into addition to free open source references, from the point of view of the institution, the major advantage of the projects is that technology has to anticipate any changes in learning processes. This change in the structure caused a more flexible technology capable of adapting to new changes, which also applies on the educational field. The major outcomes of the project is the Learning Apps Project (LAP) and the adoption of BasicLTI [54].

5.4. Utilization

There are two types of utilization available; integrating lab with OSS LMS, and encouraging the use of OSS.

5.4.1. Encouraging the use of OSS

A free open source software were introduced and they changed the world, the benefits of such use are numerous, it can be used starting from primary school, up to higher studies institutions [40]. Hailong, et al. [13] has been encouraging the use of OSS in the educational fields for quite a while, his research focuses on educational technology , responsible for Atutor, and excellent OSS e-learning hub.

5.4.2. Integrating laboratory with OSS LMS

An approach towards integrating a standalone laboratory into a SAKAI LMS was done by Wannous and Nakano [64]. It enabled the use of different activities within the context of the course presented via an e-learning environment. It was suggested that implementing original parts of the original system into Sakai, then using the link tool proved beneficial. Another model was developed by Pesquera, Morales, Pastor, Ros, Hernandez, Sancristobal and Castro [36] using both the dotLRN LMS, and Web labs from different universities in collaboration. This paved the way for remote solutions development by different papers [38], [37], increasing the efficiency with each new augmentation. Three different genres of remote controlling model were suggested by Ligus, Zolotova, Ligusova and Karch [27], they are; 1- real lab models, 2- simulated models, and 3- virtual models. It should be noted that implementing either one of those models will involve many technologies to be implemented simultaneously or natively in accordance with the Moodle system. At last, an innovative platform for both hard and software was developed by Corrado, De Vito, Ramos and Saliga [56]; it is called ADCWAN (Analog to Decimal Converters on Wide Area Network). The ADCWAN allowed harmonization of different elements and standards available for Analog to digital signals conversion, with few modifications it can also be adapted to be used in industrial electronic disciplines using contemporary technologies.

6. DISCUSSIONS

The classification proposed in this paper provides an overview of the available literature on OSS related to education. This paper provides the decision-maker or the instructor a set of active OSS that are being used by peers to do a comparison and aid in any new system implementing, specifically OSS systems in the educational field.

The obstacles facing OSS application in the educational field for both learning and teaching was drawn from the reviewed papers, those are: 1- the difficulty associated with calculating the true cost of OSS ownership, 2- the lack of information support on the vendors side, 3- the need for highly trained and skilled personnel, and 4- the lack in efficient tools to transfer commercial LMS OSS to. This study will have a contribution in the educational field, as it helps OSS LMS users to compare and choose the most suitable systems to meet their needs according to currently active systems.

7. CONCLUSION

Open source software garnered great success in a huge array of applications in different fields, this success was employed in the educational system as it has a great potential for progression. OSS LMS is

not widely spread as concluded from literature, evidence suggest that traditional systems stand inferior to OSS LMS. At any rate, OSS has to provide a viable solution for the intended use amongst educational bodies. OSS can have a dual purpose; it can serve as a building element for the system, or as ideas resource providing guidance for the system enabling it to expand rapidly covering different aspects. Current OSS applications have not been thoroughly analyzed to provide guidance for potential users.

A more deep analysis of OSS substitutes is necessary as few studies have done that before, instead of merely reporting statuses, the paper made an effort to cover the perspective of the user. The results of this paper should be useful to the research community, and can serve as preliminary material for organizations looking to adopt an OSS LMS from the list of available OSS.

ACKNOWLEDGEMENT:

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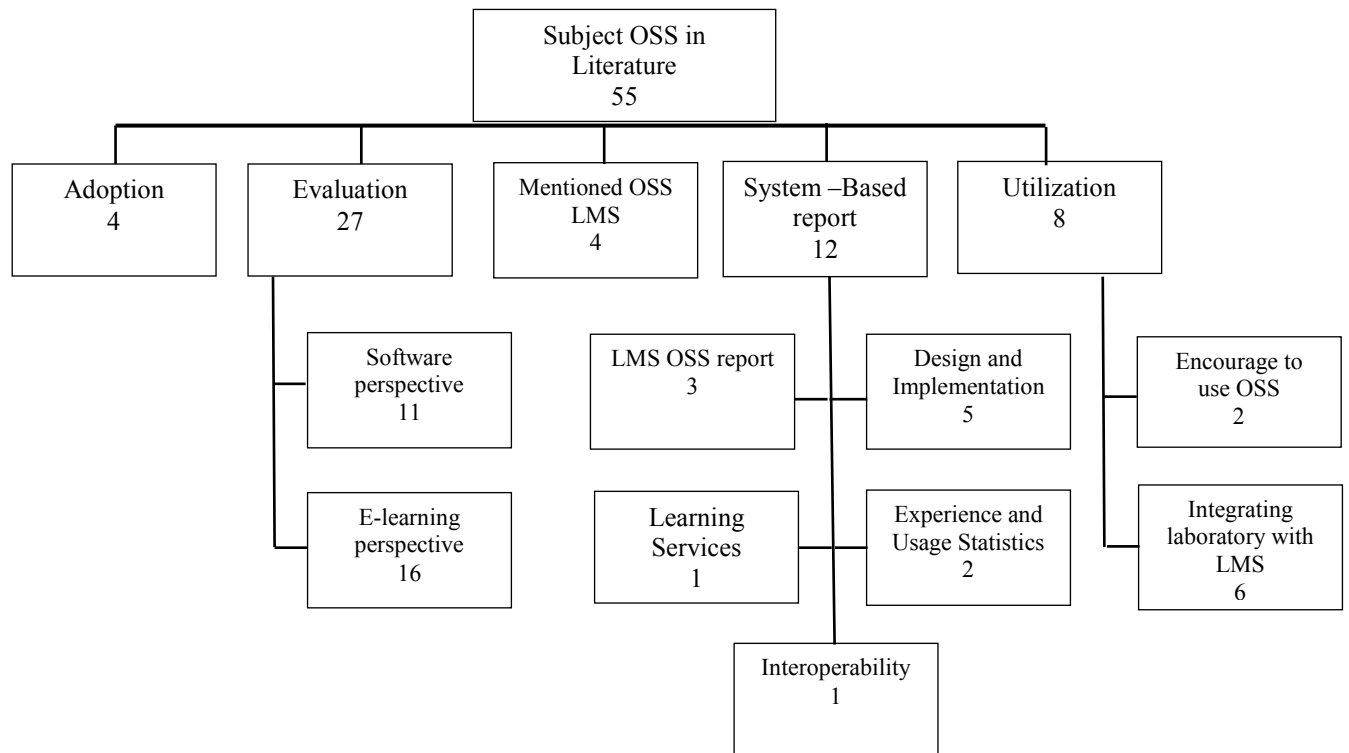
Figure 2 Proposed Simple Literature Classification