

E-Learning Management System for community schools during COVID-19 pandemic and beyond a review of some open source LMS software

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Abstract— During COVID-19 pandemic the entire conventional learning and education sector faced an unprecedented shutdown. The schools were totally closed during the pandemic. The need of suitable E-learning system over Internet or Learning Management System (LMS) software for conducting managed distance learning at school level was felt during the pandemic period. Students sitting at distinct places can use the LMS for continuing their education. LMS provide opportunity for standard and uniform learning material to the students. It may also be used to evaluate and monitor the learning progress of students. Using the LMS one can achieve improved and smooth learning path. It can also be used along with current pedagogical methods in schools. A wide range of open source software is available for online learning platform. A review of some features of Chamilo, Moodle, ATutor, ILIAS open-source Learning Management Systems (LMS) suitable for school education was conducted which is documented in this paper.

Index Terms— ATutor, Chamilo, Covid-19 pandemic, ILIAS ,learning management system, Learning Tools Interoperability, LTI, Moodle, open source, school, Web accessibility.

1 INTRODUCTION

Entire conventional learning and education sector faced an unprecedented lockdown in the COVID-19 pandemic. The schools were totally closed during the pandemic. UN Secretary-General's Policy Brief: Education during COVID-19 and beyond clearly stated that COVID-19 pandemic has affected all continents and approximately 1.6 billion learners around the world. Student population's 94 percent has been affected by the lockdowns of schools and other learning places during COVID-19 pandemic. One cannot think about peace, prosperity and productive societies if the education system collapses. The document also highlighted that the use of innovative continuous assessment methods has received a lot of attention and by using mobile phone surveys, tracking usage and performance statistics provided by learning platforms and apps and rapid learning assessment implementation student progress can be monitored and learning gaps may be identified [1].

E-learning is Internet-enabled learning using an electronic device such as Desktop computer, Laptop, Tablet computer, Mobile phone etc. Sometimes it is also called online learning or online education or online distance education.

Learning management system (LMS) is a software application or platform for the administration, documentation, tracking, reporting, and delivery of online learning courses. It can also be used to keep records of students or training participants.

The need of suitable E-learning system over Internet or LMS (Learning Management System) software for conducting managed learning at school level was felt during the Pandemic

period so that students sitting at distinct places can use the E-learning system for continuing their education .

Suitable E-learning system over Internet or LMS(Learning Management System) software for conducting managed and distance learning as well as student progress monitoring and evaluation at school level was felt during the COVID-19 Pandemic period. Various LMS software options both commercial and opensource are available. But for community based schools the opensource software is more suitable due to free cost, customization according to need, manageability of code, community based support, open standards, quality & reliability and security. A wide range of open source software is available for Internet based Learning Management System. But which software is useful for community based school is a big problem which requires a research study of long list of software and their features. A study of some features of a few open source Learning Management Systems (LMS) suitable for school education was conducted which is documented in this paper. This study may help to choose the open source LMS to be used for community based schools.

The selection of an LMS is critical and needs to be based on target of course and the needs of students. LMS must allow students to actively participate in their courses and should provide components, using which courses may be produced by instructors for students to provide active learning experiences [2].

The LMS must have learning content creation, learning management, assessment, communication, collaboration and community building tools. The suitable LMS for community schools may provide document storage and retrieval, student academic records maintenance, curriculum archive, student assessment, internal and public communication services. As community schools have a tight budget, the LMS must be economical or free of cost.

In a classroom, the impact of using Multimedia and Internet resources having e-learning content was observed and re-

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searchers presented the specifications of an open-source Learning Management System using ICT, which was implemented on a Greek High School. The LMS having storage and projection of educational multimedia files, SCORM lessons support, easy distance administration only by an Internet browser so there is no demand for technical knowledge, different kinds of users in order to provide personalization, protect the files and the parameters of the platform, videoconferencing and streaming video support giving the feasibility for synchronous education created proximity links between teachers and pupils or even better between pupils and the lesson [3].

Some widely used open-source e-learning platforms (Docebo, Moodle, Dokeos, Claroline, Atutor and Ilias) from the point of their adaptivity were compared to find solution of the problem of comparing different e-learning platforms, and on what basis to choose the most adequate one [4].

To help administrators and educators in adoption of suitable learning management system according to their needs, and for development and usage promotion of open source LMS, in terms of learning model, functional features, modules, hardware and software requirements, popular open-source tools ATutor, Moodle, eFront, OLAT, Bodington, Sakai were described and compared [5].

A comparison of ATutor, Claroline, Dokeos, Ilias, Moodle, and Sakai LMS was made in search of LMS that has best communications tools that revealed, Moodle and ATutor have the best communication tools with user friendly interface [6].

To highlight the fact that LMS have introduced more number of advancements in learning techniques by provisioning new approaches towards teaching techniques which are effective compared to trivial techniques, seven open source LMS (Moodle, Canvas, Gibbon, OLAT, Blackboard, Bright Space and Sakai CLE) were compared with their features, usability, services, functions, technical requirements and standards [7].

Four e-learning platforms Atutor, Claroline Connect, Moodle, Sakai has been compared to choose suitable e-learning platform according to user needs on the basis of functional suitability, compatibility, portability for better pedagogy [8].

To explore various digital learning platforms to provide the possible alternative solutions for interrupted education during COVID-19 pandemic the features of some of the Learning Management Systems (LMS) like Blackboard Learn, Canvas, Moodle were discussed with a special detailed report on usage of Moodle LMS [9].

Comparative study of various Massive Open Online Course (MOOC) platform shows that most platforms are designed in such a way that they mimic the traditional features of pedagogy in electronic form. [10].

2 OPEN SOURCE SOFTWARE

The open-source software is provided free of cost. Open-

source Software is made available with source code at no cost and it comes with freedom to use, study, redistribute and modify the software according to user's needs.

Open source is a very powerful means to disseminate innovation and research results [11].

Open Source software provide quick bug fixing and error correction by relying on online communities and can reduce the cost of high-quality products [12].

Generally distance learning is costly and this disadvantage of distance learning against traditional learning can be removed by using open-source software and use of open-source software in development of learning tools may improve the education quality [13].

3 STANDARDS AND SPECIFICATIONS FOR ELECTRONIC LEARNING CONTENT AND LEARNING TOOLS

Electronic learning content is a package of information about a specific topic, used to educate digital learners it takes a variety of forms, including tutorials, scenarios, podcasts, screencasts, videos, slideshows, quizzes and reference materials etc.

To assure interoperability and portability content packaging must follow standards and must provide search and discovery, accessibility and reusability [14].

To ensure the interoperability of e-learning systems, the standards of content and e-learning structure are formed so that after their compliance the interoperability and reusability may be increased for online learning content [15].

Many organizations and consortiums have developed the standards of content and e-learning structures. Some of them are discussed below.

Aviation Industry Computer Based Training Committee (AICC) started collaboration for improvement and solidification of the Experience API, with the Advanced Distributed Learning (ADL) Initiative to ensure its viability for the aviation industry and other communities served by AICC [16].

Advanced Distributed Learning (ADL) contributions are Shareable Content Object Reference Model (SCORM), Experience API (xAPI), the Department of Defense Instruction (DoDI) 1322.26 [17].

IEEE Learning Technology Standards Committee has contributed many internationally accredited standards that include Learning Technology Systems Architecture (L TSA), Data Model for Content to Learning Management System Communication, ECMAScript Application Programming Interface for Content to Runtime Services Communication, Extensible Markup Language (XML) Schema Binding for Data Model for Content Object Communication, IEEE Standard for Learning Object Metadata, XML Schema Definition Language Binding for Learning Object Metadata, Data Model for Reusable Competency Definitions [18].

CMI-5 standard was designed to bring the AICC and SCORM specifications together [19].

IMS Global Learning Consortium (IMS)- Some IMS standards are Learning Tools Interoperability (LTI), Thin Common Cartridge and OneRoster [20].

The IMS Learning Tools Interoperability(LTI) specification

allows Learning Management Systems or Platforms to integrate remote Tools and content in a standard way [21].

Several authors and organizations have proposed different ways to deal with the problem of integration of third-party external tools in Virtual Learning Environments that include IMS Learning Tools Interoperability, Basic LTI, Apache Wookie, and Group Learning Uniform Environment architecture [22].

4 WEB ACCESSIBILITY

Web accessibility allow design and development of websites, tools, and technologies such that people with disabilities can use them. Web accessibility benefits people using mobile phones, smart watches or any other devices with small screen, or devices with different input modes. Web accessibility can benefit people with temporary disabilities such as people with a broken arm or people who lost glasses. Web accessibility help people with situational limitations also such as in bright sunlight where people cannot see the device screen clearly or in an environment where cannot listen to audio, people with slow Internet connection, or limited or expensive bandwidth [23].

Web Content Accessibility Guidelines document WCAG 2.0 was published in 2008 and WCAG 2.1 was published in 2018 [24].

The three levels of conformance of WCAG technical standard are A, AA, and AAA. Level A refers to the lowest level of conformance and Level AAA is the highest.

5 REVIEW OF OPEN-SOURCE LEARNING MANAGEMENT SYSTEMS

A number of open-source Learning Management Systems are available which offer LMS basic features, that is, learning content creation, learning management, assessment, communication, collaboration and community building tools. We consider popular and freely available open source software Chamilo, Moodle, ATutor, ILIAS for this review on open source LMS for Community schools. These software are ready for deployment and can be deployed rapidly on a website or cloud without much effort.

5.1 Chamilo

Chamilo is an open-source e-learning and collaboration platform. It is distributed under the GNU/GPLv3+ license. To include the latest innovation into the Chamilo software the Chamilo association and its high technology members are working hard in the field of adaptive assessment, social and mobile learning, skills management and other similar topics. A teacher can use tools provided in Chamilo software easily and efficiently to create an effective learning environment. A teacher can import or create documents and publish them, build tests, build or import (SCORM and AICC) compliant courses, set and receive virtual assignments, communicate through forums or chat, publish announcements, add links, create work groups, set up a virtual classroom, manage scores

through the assessments tool, create surveys, add a wiki to create documents collaboratively, use a glossary, use an agenda, manage a project, enable tracking of learners in courses, register attendances, elaborate a class diary. The Chamilo platform is extremely flexible. All its tools can be customized according to the need [25]. Chamilo offers a platform that is ready for future developments in a globalized world where life long learning and collaboration will be central [26]. At present latest release of Chamilo is Chamilo 1.11.12 - Le Breuil-sous-Argenton released on 13/08/2020.

5.2 Moodle

Moodle learning platform is an open-source software distributed free of cost under the GNU General Public license. It is designed with a single robust, secure and integrated system to create personalized learning environments for educators, administrators and learners. Moodle HQ has build Moodle under Moodle project. The Moodle project is supported by an international community, a team of developers and a network of certified Moodle Partners [27]. Necessary tools to support online course and blended learning are available in Moodle. Core features of Moodle can be configured and may be enabled or disabled. Moodle has complete range of built-in features to suit course requirements. Moodle features also include collaborative tools such as forums, wikis, chats and blogs. Moodle is used widely by education, business, non-profit, government and community purposes because it is very flexible and scalable [28]. At present latest release of Moodle is Moodle 3.9.2 released on 14/09/2020.

5.3 ATutor

ATutor is an Open-source web-based LMS for development and delivery of online courses. Administrators may install or update ATutor quickly. Atutor provide development of custom themes which gives it a new look and functionality of ATutor may be extended by using feature modules. Teachers can rapidly assemble, package and redistribute e-learning content, import prepackaged e-learning content and conduct their courses online. Students use ATutor to learn in an accessible, adaptive, social learning environment [29]. ATutor was developed by Inclusive Design Research Centre, OCAD University. At present latest release of ATutor is Version 2.2.4 released on 20/07/2018.

5.4 ILIAS

ILIAS is an Open-source web-based LMS for development and delivery of e-learning courses. To reduce the cost of using new media in education, ILIAS was developed. ILIAS is distributed under the GNU General Public license [30]. ILIAS is useful for Higher Education, Businesses, Schools and Public Authorities. ILIAS contain test and assessment tool that enable users to check their own learning progress and it may be used to carry out complete e-exams. At present latest release of ILIAS is 6.5 (stable) released on 23/10/2020.

6 COMPARISON OF OPEN SOURCE LEARNING MANAGEMENT SYSTEMS

6.1 General Information

We have considered popular and freely available open source software Chamilo, Moodle, ATutor, ILIAS for this review on open source LMS for Community schools. General Information about these LMS are provided in Table 1.

Table 1
Open-source LMS general information

LMS	Licence	Targets
Chamilo	GNU/ GPL	Universities, Schools, Business
Moodle	GNU/ GPL	School, University
ATutor	GNU/ GPL	Government, University
ILIAS	GNU/ GPL	Businesses, Universities, Schools and Public Authorities

6.2 Websites of considered LMS

Information about websites of considered LMS are provided in Table 2.

Table 2
Open-source LMS websites

LMS	Website
Chamilo	https://chamilo.org
Moodle	https://moodle.org
ATutor	https://atutor.github.io
ILIAS	https://www.ILIAS.de

6.3 Technical Overview

Detailed technical overview, for the four open source LMSs are shown in Table 3.

Table 3 shows that Chamilo, Moodle and Atutor has WCAG certified accessibility. LMSs Chamilo, Moodle, ATutor, ILIAS are SCORM compatible and are LTI certified.

Table 3
Technical overview of learning management systems

LMS	Chamilo	Moodle	ATutor	ILIAS
First release	Version 1.8.6.2 re-release date 18/01/2010	August 2002	2002	2/11/1998
Latest version and release date	Chamilo 1.11.12 - Le Breuil sous Argenton released on 13/08/2020	Moodle 3.9.2 released on 14/09/2020	Version 2.2.4 released on 20/07/2018	6.5 (stable) released on 23/10/2020
Programming language	PHP	PHP	PHP	PHP
Supported Database	MySQL	MySQL, MS SQL Server, PostgreSQL, Oracle	MySQL	MySQL, Oracle, PostgreSQL
Interoperability	AICC, IMS LTI, IMS QTI, PENS, SCORM 1.2	Learning Tool Interoperability (LTI) v2.0, SCORM v1.2, IMS CP, AICC (CBT), SCORM 2004, xAPI/Tin Can API	OpenSocial 1.0, OAuth Authentication Protocol, IMS Content Packaging 1.1.2+, SCORM Content Packaging, SCORM 1.2 LMS RTE3, IMS Question Test Interoperability (QTI) 1.2/2.1, IMS LTI 1.0 (reg. IMSA1B1as2012W1), IMS Common Cartridge 1.0 (reg. IMSA1B1as2012W1, IMSA2B1as2013W1), W3C XHTML 1.0	SCORM 1.2, SCORM 2004, LOM metadata, IMS QTI tests, IMS LTI
Accessibility	WAI WCAG Level AAA	WCAG AA	W3C WCAG 1.0, W3C WCAG 2.0, W3C ATAG 2.0, US Section 508, Italy Stanca Act, IMS AccessForAll 2.0, ISO/IEC 24751	

6.4 Features and Functionality Overview

The target of this review is to identify important features and functionality of the four LMSs. This discussion will help to select proper open source LMS for community based schools according to their needs. To discuss the important features of the four open source LMSs following entities are used-

6.4.1 Forum

The Forum is a tool which allows creation and management of discussion of topics within a course. Forum is a public or semi-public space, where several people can see posted information.

6.4.2 Quiz or Test

Quiz or Test feature enables a teacher to create quizzes comprising test questions of various types, including multiple choice multiple answer, multiple choice single answer, matching, short-answer and numerical.

6.4.3 Resource

A resource may be a file or link that a teacher can use to support learning.

6.4.4 Announcements

Announcements are used by teachers to post some important information about course which appears on site home page or course home page, so that a user can notice it when logged in.

6.4.5 Group Management

Through Group Management Teachers can create and manage groups and assign students to groups so that group can be assigned some learning tasks.

6.4.6 Student Profile

Students can create their profiles.

6.4.7 Calendar

Calendar is used to add, modify and delete events and activities for user, groups, courses and the site. Activities like assignments, quizzes, discussion can be scheduled by using Calendar.

6.4.8 Assignments/Projects

Teachers can create and grade assignments, it enables teachers to assign tasks, collect work and provide grades and feedback.

6.4.9 Chatting

Chatting means instant messaging which allows users to users in a course to exchange ideas, questions and answers in real time written conversations.

6.4.10 Glossary

Glossary tool allow users to define terms or expressions used in course contents in the same way as a dictionary. Students can see the explanation of terms while reading course contents.

6.4.11 Wiki

The Wiki tool is a collective or collaborative redaction tool which allows participants to work together on a single document, and to follow the history of modifications.

6.4.12 Course Management

Teachers can control access to learning material, release assignments, make announcements, backup and restore courses.

6.4.13 Assessment

Using The Assessments tool a teacher, can evaluate student's

achievements and give feedback and scores and may define success criteria like the pass mark, merit rankings for the course.

6.4.14 Internal Email

Internal Email may be used by the teachers, students to send and receive email to communicate with each other. Teacher can limit mailing to students, groups.

6.4.15 Online Discussions

Teachers may allow students to participate in discussions through the chat or discussion forums tools. Teachers can review posts, lock forum from read, edit and delete posts.

6.4.16 Grade Book

Teachers use grade book to calculate, store and distribute grade information to students.

6.4.17 Notes

Using Notes feature student can write down their observations, notes, thoughts during study of learning contents.

6.4.18 RSS Feeds

RSS Feeds are used to show latest information about courses. RSS feed can be turned on to display RSS feed from other Web sites also.

6.4.19 Survey/Polls

Survey or polls are conducted by teachers to get course members opinions.

6.4.20 Reports

Site reports, course reports, user reports, activity reports, participation reports, overview reports, logs and statistics report etc.

6.4.21 Content Sharing

Sharing of course contents is possible with other teachers or students. Teachers can import/export course contents that are to be reused.

6.4.22 Drop Box

After completion of their assignments, provided by the teacher, students may upload required documents to the drop box.

6.4.23 Customized Look

Users can customize the look of LMS interface according to their needs.

6.4.24 Upload and Share Documents

LMS users may upload and share documents using of file storage area that may be kept personal or shared with other users.

6.4.25 Multilingual Support

Multilingual Support for LMS may be obtained by installing additional languages using additional language packs.

6.4.26 Community Support

The open-source software communities play important role in building and improving the respective LMSs. Community support is available for users of mentioned LMSs in form of email lists, wikis, technical documentation, forums, Blogs etc.

6.5 Open source LMS grouping of features

A Learning Management System (LMS) can be analyzed by sorting the features into four groups; tools for distribution, tools for communication, tools for interaction and tools for course administration [31].

Table 4
Open source LMS grouping of features

Tools for distribution	Tools for communication	Tools for interaction	Tools for course administration
Resource	Internal Email	Forum	Group Management
Announcements	Calendar	Quiz or Test	Grade Book
RSS Feeds	Student Profile	Assignments	Survey/Polls
Content Sharing	Video Conference	Online Discussions	Reports

Tools for distribution are the features of LMS that allow teachers to upload course contents, available to students. This is one-way distribution of information from teacher to learner.

Tools for communication are the features of LMS that allow information to go from teacher to student or from student to teacher as well as from student to student.

Tools for interaction are the features of LMS that call for reaction and feedback.

Tools for course administration are the features of LMS that are used to monitor and document the educational process, rather than facilitate teaching.

Features of open source LMSs may be grouped in tools for distribution, tools for communication, tools for interaction, tools for course administration. The mentioned Groups of features are listed in Table 4.

6.5.1 Availability of tools for distribution

Availability for tools of distribution in Chamilo, Moodle, ATutor, ILIAS is shown in Table 5.

Table 5

Open-source LMS availability of tools for distribution

Tools for distribution	Chamilo	Moodle	ATutor	ILIAS
Resource	yes	yes	yes	Yes
Announcements	yes	yes	yes	Yes
RSS Feeds	yes	yes	yes	Yes
Content Sharing	yes	yes	yes	Yes

6.5.2 Availability of tools for communication

Availability of tools for communication in Chamilo, Moodle, ATutor, ILIAS is shown in Table 6.

Table 6

Open source LMS availability of tools for communication

Tools for communication	Chamilo	Moodle	ATutor	ILIAS
Internal Email	yes	yes	yes	Yes
Calendar	yes	yes	yes	Yes
Student Profile	yes	yes	yes	Yes
Video Conference	yes	yes	yes	yes

6.5.3 Availability of tools for interaction

Availability for tools for interaction in Chamilo, Moodle, ATutor, ILIAS is shown in Table 7.

Table 7

open source LMS availability of tools for interaction

Tools for interaction	Chamilo	Moodle	ATutor	ILIAS
Forum	yes	yes	yes	yes
Quiz or Test	yes	yes	yes	yes
Assignments	yes	yes	yes	yes
Online Discussions	yes	yes	yes	yes

6.5.4 Availability of tools for course administration

Availability for tools of distribution in Chamilo, Moodle, ATutor, ILIAS is shown in Table 8.

Table 8

Open source LMS availability of tools for course administration

Tools for course administration	Chamilo	Moodle	ATutor	ILIAS
Group Management	yes	yes	yes	yes
Grade Book	yes	yes	yes	yes
Survey/Polls	yes	yes	yes	yes
Reports	yes	yes	yes	yes

tor, ILIAS is shown in Table 8.

By observing Table 5, Table 6, Table 7 and Table 8 we may deduce that tools for distribution, tools for communication, tools for interaction and tools for course administration are available in Chamilo, Moodle, ATutor, ILIAS open source LMSs. Hence the mentioned four LMSs Chamilo, Moodle, ATutor, ILIAS cover basic feature requirements of LMS.

6.6 User roles overview

Open source LMSs Chamilo, Moodle, ATutor, ILIAS support a number of user roles. Different user roles may have different set of permissions for user. Supported user role types are listed in Table 9.

Table 9
User roles in learning management systems

Chamilo	Moodle	ATutor	ILIAS
Main administrator	Guest	Administrators	Administrator
The sessions administrator	Authenticated user	Instructors	Anonymous
Session coach	Student	Students	Guest
Courses coaches	Non editing teacher		User
The teacher	Teacher		
The students	Course creator		
Human resources manager	Administrator		

User Role management in ILIAS and ATutor is a little bit complicated.

The default interface of ILIAS is more complicated than Moodle and Atutor [32].

6.7 Language overview

Moodle has Multi language support. To work in any language in Moodle a suitable language pack has to be installed. Moodle has more than 100 language packs that administrators may install on their Moodle site. Hindi language pack is also available [33], [34]. Chamilo has translations in more than 34 languages [35]. Atutor has more than 20 languages pack [36]. ILIAS open source LMS manages 28 different languages [37].

7 CONCLUSIONS

The reviewed LMS software are open source and published under GNU/GPL License. Open source software is made available with source code at no cost and it comes with freedom to use, study, redistribute and modify the software according to user's needs.

The reviewed LMSs offer important online tools for learning support and design. They also offer improvement in teaching

methods by providing various tools for storing and organizing teaching content, interactive learning, tracking the progress of learning process, conducting exams and preparing results.

Electronic learning content packaging must comply to standards to assure its interoperability and portability. Reviewed LMSs are compatible with SCORM and are LTI certified. This allows more exchange of Electronic learning content and use of external learning tools.

LMS provide a way to continue the interrupted education during COVID-19 pandemic. LMS can also be used along with current pedagogical methods in schools.

Despite the fact that all the reviewed LMSs have all basic features of an modern LMS and any one of them can be used for conducting online learning, the analysis of these LMSs shows that each has its own strengths and limitation.

Chamilo LMS is made for ease of use and accessibility Moodle is highly configurable and customizable LMS, generally suitable for all LMS requirements. Moodle has more than 100 language packs that administrators may install on their Moodle site. Hindi language pack is also available. It is the most popular among the reviewed LMS software.

ATutor supports more Interoperability standards among reviewed LMS software.

ILIAS has powerful Test and Assessment tool that allows users to check their own learning progress and also makes it possible to carry out complete e-exams.

Reviewed LMS software do improved accordingly with the improvement in information technology. However further research may be required in the field of electronic learning content sharing, learning tools interoperability, accessibility, self-guided learning and use of artificial intelligence in E-learning etc.

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