# A Comparison of Open-Source Learning Management Systems Used for Distance Education in Higher Education Institutions

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## Abstract

In recent years, advancements in digitalization and internet technologies have facilitated the widespread adoption of distance education and blended learning models in higher education institutions. In this process, Learning Management Systems (LMS) have become essential tools that enhance the quality of education by providing functions such as sharing educational materials, organizing exams, and monitoring student performance. Open-source LMS platforms stand out due to their customizable structures, cost advantages, and strong community support. This study analyzes the strengths and weaknesses of open-source LMSs commonly used in higher education institutions, such as Moodle, Open edX, Sakai, ILIAS, and Canvas. Based on criteria such as user-friendly interfaces, plugin options, data security, and technical support, this review assesses the systems' contributions to educational processes and user experiences. The findings reveal that Moodle and Open edX, with over 140 million and 14 million users respectively, excel in scalability and analytics capabilities, while platforms like Chamilo and Dokeos are more suitable for smaller institutions due to their simplicity and lightweight structure. The study concludes that open-source LMS platforms, with their flexible and economical structures, provide effective tools for supporting the digital transformation of education and offers guidance for selecting suitable platforms to meet institutional goals.

*Keywords:* "Learning management system (LMS), distance learning, higher education."

## 1.   Introduction

The rapid advancement of digitalization and developments in internet technologies in the 21st century have led to a profound transformation in educational processes. In particular, higher education institutions have increasingly shifted toward online and blended learning models in addition to traditional face-to-face education, with LMS playing a pivotal role in this transition. Distance education provides students with the opportunity to learn independently of time and location, while offering instructors the ability to reach a wide audience and effectively manage educational content. In this context, LMS software used in higher education institutions has become a critical tool with the potential to enhance the quality and efficiency of education.

LMSs provide a wide range of functions, including sharing course materials, conducting online exams, monitoring student performance, and managing forums and discussion environments. However, for these systems to be effectively used in graduate and undergraduate education, universities must offer flexible and cost-effective solutions that meet their specific needs. In this regard, open-source LMS software stands out due to its cost advantages, customizable structures, and extensive community

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support. Academic institutions, in particular, can adapt and customize their educational processes according to their needs, leveraging the flexibility and scalability offered by open-source software.

This study analyzes open-source LMSs used for distance education in higher education institutions, highlighting their strengths and weaknesses. A comparative analysis of widely used open-source LMS platforms such as Moodle, Open edX, Sakai, ILIAS, and Canvas will be conducted to assess the systems' contributions to educational processes and examine user experiences. In this scope, a detailed review will be carried out, taking into account various criteria such as user-friendly interfaces, technical support, plugin and module options, and data security.

The aim of this study is to identify the most suitable open-source LMS options for higher education institutions and to provide insights into future educational policies by analyzing trends in this area. Additionally, recommendations for the effective use of different LMS platforms will be presented, discussing how universities can achieve maximum efficiency in their distance education processes. In this context, the study's results aim to serve as a guide for decision-makers, academics, and system administrators in the field of educational technologies.

## 2.    Open-Source Learning Management Systems

E-learning encompasses learning activities conducted solely over the internet, which can also be facilitated through video conferencing tools. However, for a more systematic learning process, a web-based system involving the participation of both students and instructors is necessary. These systems include various operations such as tracking student statistics, utilizing multimedia content, sharing course materials, and organizing exams. Such systems are referred to as LMS. LMS platforms are used by educational institutions, universities, companies, and governments to manage e-learning processes. Companies use LMS not only for employee training but also for customer training programs [1].

LMS platforms emerge as powerful tools to support and enhance digital education processes. Due to their flexible structures, cost advantages, and customizability, these systems effectively support distance education and blended learning models, particularly in higher education institutions. Open-source LMS platforms provide a modular structure that can be adapted to the specific needs of institutions [2], and they are continuously developed and updated with extensive community support. Platforms like Moodle, Open edX, Sakai, and Canvas offer a range of functions, including sharing course materials, conducting online exams, tracking student performance, and creating collaborative learning environments, all aimed at enhancing the quality of education. These systems not only meet technical requirements but also play a critical role in achieving pedagogical objectives. In today's rapidly accelerating digitalization of education, open-source LMS software provides an ideal solution for institutions seeking flexible, accessible, and scalable options.

### 2.1.    Moodle

Moodle (Modular Object-Oriented Dynamic Learning Environment) is an open-source LMS developed to enable educators to create, manage, and interact with online courses. Initially developed in 2002 by Martin Dougiamas, Moodle is widely used by schools, universities, companies, and other educational institutions worldwide. The primary goal of Moodle is to support distance education and transition learning processes to digital platforms.

Moodle features a modular structure that can be customized according to the needs of educators. It offers tools such as course management, assessment tools, assignment submissions, exam modules, discussion forums, surveys, and multimedia support. Additionally, Moodle supports standards like SCORM and LTI, enabling integration with other learning systems and tools. Its components include:

- Course Modules: Tools for course content, exams, and assignments.
- Interaction Tools: Forums, chat rooms, and group projects.
- Reporting and Tracking: Tools for tracking and reporting student performance.
- Plugins and Theme Support: The system can be customized with plugins and themes developed by the Moodle community.

Technically, Moodle can run on virtually any computer that supports PHP programming language and SQL-type databases. Its modular structure offers a range of tools to meet diverse user needs. For example, the Assignment Module allows instructors to collect assignments, grade them, and provide feedback, while the Chat Module enables real-time communication. The Database Module allows users to create a configurable database. The Forum Module facilitates communication between students and instructors, and the Glossary Module allows users to add terms and definitions [5]. Users can easily access different modules online, and each user is authorized through a role-based membership system, with a single account per server. The system, managed in a portal-style, can terminate access for students who have been inactive for a specified period. Additionally, instructors can view forum and survey content via email, if desired [6].

One of Moodle's greatest advantages is its open-source nature and free availability, which allows institutions to customize the system and reduce costs. Moreover, its user-friendly interface and rich feature set make it suitable for educational institutions of all levels. However, some disadvantages include the need for technical expertise and the requirement for a robust infrastructure for large-scale usage. Some users have pointed out that the learning curve for Moodle can be steep initially.

Moodle can be used across a wide range of institutions, from elementary schools to universities, private companies, and government agencies. It is particularly ideal for distance education programs, blended learning environments, and in-house training. Universities, companies offering employee training programs, and organizations creating educational platforms are among the primary users of Moodle. With its advanced features and flexible structure, Moodle offers an effective solution for any institution seeking to digitalize their learning processes.

## 2.2. Open edX

Open edX is an open-source LMS platform developed under the leadership of MIT and Harvard University. Initially launched in 2013, Open edX is designed to create, manage, and deliver online courses and educational materials. The platform is particularly favored by higher education institutions, companies, and online education providers. Open edX enables users to manage remote learning processes, create blended learning environments, and provide interactive learning experiences. Open edX features a robust modular architecture and scalability. The system offers a variety of tools, including course creation tools, video integration, exam modules, interactive content, discussion forums, and analytics tools. It has a user-friendly interface and is supported by a large developer community. The core components of Open edX include:

- Studio: The tool used for creating and editing course content.
- LMS: The main platform where students access and interact with content.
- XBlock Framework: A modular framework used to customize and extend learning components.
- Analytics and Reporting: Advanced tools for tracking and evaluating student performance.

One of the most significant advantages of Open edX is its high degree of customizability and its ability to cater to a large user base. The advanced analytics tools allow institutions to track student performance in great detail. Additionally, the platform's open-source nature enables cost savings and customization to meet specific needs. A notable disadvantage, however, is the high technical expertise required for setup and management, as well as the need for a robust infrastructure. Furthermore, the complexity of the platform may pose a barrier for small-scale educational initiatives.

Open edX is an ideal platform for universities, large-scale companies, government institutions, and online education providers. Used by prestigious institutions such as Harvard and MIT, it is also preferred by global companies for managing employee training. Additionally, educational entrepreneurs and non-governmental organizations can utilize the platform to reach a broad audience. The flexible structure of Open edX makes it suitable for addressing educational and learning needs at all levels.

## 2.3. Sakai

Sakai is an open-source LMS developed by several universities in the United States in 2004. Designed for universities, companies, and educational institutions, the platform provides tools for online course management, sharing learning materials, assessment, and collaboration. Sakai is used to manage educational processes in a digital environment and enhance efficiency. It also offers flexibility, allowing users to customize their learning experiences.

Sakai features a user-friendly interface and a wide modular structure. The platform includes various functionalities such as course creation, exam and assignment management, student communication, forums, and group work. The core components of Sakai include:

- Course Management: Tools for instructors to upload, organize, and share course materials.
- Assessment Tools: Tools for creating tests, exams, and surveys.
- Collaboration Tools: Collaboration platforms for group projects and discussions.
- Gradebook: Used for tracking and analyzing student grades.
- Integration Tools: Allows easy integration with external applications and systems.

Sakai is a web-based software designed for education and collaboration, enabling users to create course sites without requiring HTML knowledge. Instructors can utilize various features such as announcements, resource sharing, online assessment, discussion forums, and messaging. The assessment tools offer individualized evaluations with specific notifications for students, while the announcement and chat tools facilitate communication. Additionally, collaboration is supported through features like shared folders and email integration. Sakai includes various components to simplify site and tool management. The program tool presents organization in a calendar format, while features like Wiki and WebDav support collaborative work and file management. The course site tool assists in the creation of course and project sites through guided steps. Widely used by

universities such as Michigan, Indiana, MIT, Stanford, and Sabancı, Sakai offers a comprehensive platform for institutions seeking to effectively utilize technology in education. Thanks to its open-source structure, institutions can customize the platform to meet their specific needs and add new features.

One of Sakai's main advantages is its open-source and free nature. This reduces costs for educational institutions while allowing users to tailor the platform to their needs. Furthermore, Sakai is supported by a large community and is continuously updated. The platform's flexible integration capabilities enable seamless cooperation with various third-party tools. As a disadvantage, Sakai requires technical knowledge for installation and maintenance, and it may be complex for small-scale institutions. Additionally, the user interface may be considered less modern and intuitive compared to some other LMS platforms.

Sakai is primarily used by higher education institutions (universities) and research organizations. Its flexible structure allows it to be used in both academic and institutional environments. It is especially suitable for institutions seeking an open-source solution and possessing the technical capacity to customize the platform. Many universities and companies worldwide prefer Sakai to improve learning management and collaboration processes.

## 2.4.    ILIAS

ILIAS (Integrated Learning, Information, and Work Cooperation System) is an open-source LMS developed in 1998. Designed to digitize educational and business processes, this platform caters to a wide range of users. Offering tools for online course creation, content sharing, exam management, and collaboration, ILIAS is particularly preferred by higher education institutions, vocational training centers, and businesses. ILIAS provides a wide range of features that can be customized according to users' needs, thanks to its modular structure. The platform's key features and components include:

- Course Management: Provides instructors with tools to upload, organize, and share course materials.
- Exams and Assessment: Includes tools for creating tests, surveys, and automated assessment tools.
- Learning Material Management: Facilitates sharing content in various formats such as videos, texts, and presentations.
- Collaboration Tools: Provides tools for forums, chat rooms, and group projects.
- Tracking and Reporting: Allows tracking students' progress and reporting on their performance.

ILIAS offers each user a personalized desktop workspace. Users log in to access courses and manage their profiles and settings, which are protected by security passwords. The platform includes several functionalities such as remembering the last accessed point, note-taking, viewing internal news, using a calculator, and tracking learning progress. It also features course management tools such as managing learning resources, time-restricted access, tracking the learning steps of course members, member galleries and maps, course news, and announcements. For communication, the platform offers internal messaging, chat, and forums. The test and assessment tools support various question types, including multiple choice, single choice, mixed tests, comparison, and ranking, as well as features such as question pools, random question selection, and exercise organization. Additionally, functionalities like categorizing questions and organizing daily tasks are designed to optimize both the learning process and the user experience.

One of the most notable features of ILIAS is its compliance with international standards such as SCORM (Sharable Content Object Reference Model). This facilitates the integration of the platform with other educational software. The advantages of ILIAS include being open-source, supported by a large community, and its flexible structure. The platform enhances the user experience by allowing educational materials to be presented in various formats. Furthermore, it enables users to customize their personal learning environments. However, ILIAS has its disadvantages. The installation and configuration of the platform may require technical knowledge. Some users may find the interface less intuitive compared to more modern LMS platforms. Additionally, the comprehensive structure of the system may seem complex for small-scale businesses initially.

ILIAS is used across a broad range of organizations, from higher education institutions to vocational training centers, government agencies, and businesses. It is particularly suitable for institutions aiming to digitize extensive education and assessment processes. It is widely used by universities and educational organizations in many European countries, especially in Germany. ILIAS offers a robust digital learning and collaboration platform for both academic and corporate users.

## 2.5.    Canvas LMS (Open Source Version)

Canvas LMS is an open-source LMS designed to facilitate the online learning experience for educational institutions and businesses. Developed by Instructure, this platform is primarily used by universities, schools, and corporate training departments seeking to digitize teaching management. With its flexible structure and user-friendly interface, Canvas LMS allows instructors and students to easily access online course materials.

Canvas LMS offers a comprehensive feature set tailored to the needs of its users:

- Course Management: Enables the creation, sharing, and organization of course materials.
- Assessment and Grading: Provides tools for automatic grading, rubrics, and detailed tracking of student performance.
- Communication and Collaboration: Includes forums, instant messaging, video conference integrations, and tools for group work.
- Mobile Compatibility: Offers mobile applications for both instructors and students, ensuring easy access.
- Integrations: Easily integrates with other educational tools via SCORM, LTI (Learning Tools Interoperability), and API integrations.

Additionally, the open-source version allows users to customize the platform to suit their specific needs.

One of the major advantages of Canvas LMS is its modern, user-friendly interface, which provides an easy learning curve. While offering powerful tools for instructors, students, and administrators, the open-source nature of the platform provides opportunities for customization and integration. Its full compatibility with mobile devices makes it easier for students to access courses anytime and anywhere. However, users of the open-source version are responsible for hosting and technical management, which may require technical expertise. Additionally, some features may be more limited compared to the commercial version, and reliance on community resources for technical support may be considered a disadvantage.

Canvas LMS is widely adopted by universities, high schools, and corporate training units worldwide. It is particularly suitable for higher education institutions looking to improve the online learning experience. Businesses also use Canvas LMS for employee training and development. Its open-source nature makes it a popular choice among organizations seeking a low-cost solution.

## 2.6. Chamilo

Chamilo is an open-source LMS designed to facilitate online educational processes. It is an ideal platform for organizations and individuals seeking to create, share, and manage educational materials. Chamilo's target audience includes universities, schools, corporate training departments, and non-profit organizations. Its user-friendly interface and low system requirements make it an ideal solution for both organizations with limited technical infrastructure and large-scale educational providers.

As a comprehensive LMS, Chamilo offers the following key features:

- Course Management: Instructors can create, edit, and assign course materials to students.
- Assessment and Evaluation: Provides tools for creating exams, quizzes, and assignments.
- Communication and Collaboration: Includes support for forums, instant messaging, and group work.
- Learning Paths: Offers a modular structure to personalize students' learning processes.
- Reporting and Tracking: Contains advanced reporting tools for analyzing user activity and performance.
- Mobile Compatibility: Provides easy access to the platform from mobile devices.
- Multilingual Support: Supports multiple languages, making it suitable for international use.

The components include user management, document sharing, video integration, certification, and SCORM compatibility. Among Chamilo's advantages are its simple installation, user-friendly interface, and extensive community support. Its open-source structure allows for customization, and integration with other systems is straightforward. With its low hardware requirements, Chamilo offers a cost-effective solution, particularly for small and medium-sized institutions. However, it may have limitations for organizations seeking advanced technical features or large-scale operations. For example, it may fall short in handling more complex reporting or big data processing needs. Technical support is primarily based on community forums, which could be a disadvantage for users seeking personalized assistance.

Chamilo appeals to a broad user base seeking to leverage educational technologies effectively. It is favored by universities, schools, and educational institutions, as well as businesses managing employee training and competency development programs. Additionally, Chamilo is an appropriate choice for non-profit organizations running low-budget educational projects. Its flexible structure allows it to be adapted to the educational needs of various types of institutions.

## 2.7. ATutor

ATutor is an open-source web-based Learning Content Management System (LCMS), developed in 2002 with a primary focus on accessibility. The platform is designed to ensure equal participation in the educational process for individuals with disabilities. As such, it is structured in compliance with WCAG (Web Content Accessibility Guidelines) and other international standards. The software adheres to the disability standards set by the American Society for Training and Development (ASTD).

Its modular architecture allows for extensibility, making it possible to enhance the system with third-party extensions. ATutor supports the IMS/SCORM standards for content developers, ensuring compatibility for educational materials. Additionally, the platform operates independently of the underlying operating system, functioning across Microsoft, Linux, UNIX, and Mac OS X environments. The Adaptive Technology Resource Centre at the Faculty of Information Studies, University of Toronto, has contributed to ATutor and various other projects in this field, focusing on the development of educational technology standards.

ATutor offers a range of robust features to support online learning processes. It includes components and functionalities such as file storage, forums, communication tools, content packages, test management, messaging, SCORM support, student tools, assessments, reading lists, news, announcements, and frequently asked questions. Key components of ATutor include course modules, user management, forums, file sharing, and reporting tools. The main features of ATutor are as follows:

- Accessibility: Its design is optimized for accessibility, particularly for groups such as individuals with visual impairments.
- Course Management: Instructors can easily create and organize course content.
- Test and Evaluation Tools: Facilitates assessment through multiple-choice, true/false, and open-ended questions.
- Adaptive Themes: Provides customizable interface options based on user needs.
- SCORM Compatibility: Supports the sharing of educational materials in compliance with international standards.
- Student Tracking and Reporting: Includes tools for analyzing student activity and performance.
- Modular Structure: Allows the integration of additional features through extensible plugin support.

One of ATutor's greatest advantages is its full compliance with accessibility standards for individuals with disabilities. Additionally, its open-source nature offers high customization potential at a low cost. The platform's simple installation process and user-friendly interface make it accessible even for users without technical expertise. Its modular structure ensures ease of updates, and students can modify their learning environment based on available templates. The platform also supports features such as graphics and forums, and when using the ATutor content editor, instructors can control the accessibility of the content accessible by all students. Various component types are used to add additional functionality to ATutor, with the primary aim of creating application-linked components within the system, offering interactive features and enhancing user convenience. However, ATutor has certain limitations. It may fall short for large-scale users seeking advanced features. Additionally, community support may sometimes be limited, and the frequency of platform updates could be lower compared to other LMS solutions.

ATutor offers an effective solution for educational institutions and individual instructors. It is particularly preferred by organizations focusing on accessibility standards. It is an ideal choice for schools, universities, non-profit organizations, and government projects. Moreover, small and medium-sized businesses looking to support employee training and professional development can also utilize ATutor. Its goal of ensuring full participation of individuals with disabilities in the educational process makes ATutor a unique option in this field.

## 2.8. Claroline

Claroline is an open-source LMS used for the creation, sharing, and management of online educational materials. Initially developed by the Catholic University of Louvain in Belgium, this platform provides a digital learning environment for both instructors and students. Claroline, designed for both teaching and collaboration purposes, is favored by educational institutions, workplaces, and non-profit organizations due to its flexible structure.

Claroline offers a range of features to ensure an effective learning experience:

- Course Management: Enables instructors to create, organize, and share course materials.
- User Management: Manages user access with different roles (instructor, student, administrator).
- File Sharing: Facilitates the sharing of materials with students.
- Activity and Task Management: Organizes tasks and events through calendar integration.
- Forums and Discussion Areas: Provides forums for interaction and collaboration among students.
- Test and Evaluation Tools: Allows instructors to create exams and assess results.

Claroline's modular structure allows the easy addition of various components to the system. Some of these components include forums, surveys, assessment tools, and reporting features.

Among the advantages of Claroline are its open-source nature and flexible architecture. These features make it easier for different institutions to customize the platform according to their specific needs. Additionally, its user-friendly interface minimizes the technical knowledge required for use. Online collaboration tools promote teamwork and support distance learning processes. However, some of the disadvantages of Claroline include limited scalability for large-scale users. Its user interface, which is less advanced compared to modern LMS solutions, and limited integration options may negatively impact the user experience. Additionally, community support is more limited compared to popular alternatives like Moodle.

Claroline is particularly ideal for small to medium-sized educational institutions and workplaces. Schools, universities, and professional training providers can use Claroline to digitize course materials and create online learning environments. Focused on enhancing students' pedagogical experiences and needs, Claroline does not require specialized technical knowledge for daily platform management. The platform can be quickly set up and easily managed via web browsers, allowing users to register for various courses. Claroline is structured around pedagogical activities or course content areas. Each area provides a set of tools to support the creation of learning materials, management of educational activities, and interaction with students. Moreover, non-profit organizations and businesses wishing to manage employee training programs can also benefit from this platform. Its simple structure offers an effective solution for organizations with limited technical infrastructure.

## 2.9. Opigno LMS

Opigno LMS is an open-source LMS built on the Drupal infrastructure. Designed for both corporate training and academic purposes, Opigno offers users a customizable and scalable learning platform. This system is intended for the creation, management, and delivery of online educational materials, providing a modern user experience. It is widely used by businesses offering e-learning and professional development programs.

The core features offered by Opigno LMS include:

- Flexible Course Management: Instructors can easily create, edit, and assign course content to students.
- Certification and Examinations: Automatically generates certificates upon course completion and facilitates exam creation.
- Gamification: Enhances motivation by integrating reward systems and badges into the learning process.
- Role-Based Access: Provides customized access for different user types, such as instructors, students, and administrators.
- Statistics and Analytical Tools: Offers detailed reports for analyzing user performance.
- Mobile-Friendly Design: Allows users to access courses conveniently from mobile devices.

Components of Opigno LMS include training modules, video conferencing integration (e.g., Zoom), forums, surveys, tests, and customizable dashboards. Thanks to its Drupal infrastructure, the system can be expanded to meet specific needs by adding new modules.

The advantages of Opigno LMS include its open-source nature and the strong customization capabilities enabled by its Drupal foundation. Its scalable structure supports large user groups, and modern e-learning features like gamification and certification enhance user motivation. Mobile compatibility allows users to access content from anywhere. However, there are some disadvantages. Due to the Drupal infrastructure, the installation and management of the system require technical knowledge, which may increase the demand for technical support. Additionally, as it is less popular than other open-source LMS solutions, community support may be more limited.

Opigno LMS caters to a wide range of users, particularly large enterprises that use it for managing employee training programs. Universities and schools can also use the system to offer online courses. Furthermore, non-profit organizations and professional training providers can benefit from Opigno's customizable structure. It is an ideal solution for organizations with technical infrastructure and those seeking flexibility in customization.

## 2.10. Dokeos

Dokeos is an open-source LMS developed with contributions from various international organizations, universities, and individual contributors. This system is widely used not only in the academic field but also by companies for e-learning and blended learning programs. Operating on a MySQL database and written in PHP, Dokeos is a web-based application that offers key features such as SCORM compliance and LDAP authentication support. Dokeos serves as an efficient tool for educators and institutions in the creation, management, and distribution of educational materials. It provides a robust infrastructure for online courses, exams, assessments, and interactive training. One of the standout features of Dokeos is the ability to import SCORM-compliant course content and PowerPoint presentations through the Oogie Rapid Learning package. Additionally, with the Videoconferencing package, virtual classrooms can be created, and synchronous training and virtual meetings can be held, setting it apart from other LMS platforms.

Key features of Dokeos include:

- Course Management: Educators can easily create and assign course content. Various formats (text, video, tests, etc.) can be used for content creation.
- Exams and Assessments: Online exams can be created, and student performance can be closely monitored. Instant feedback is provided to students.

- Communication Tools: Interactive tools such as forums, messaging, and announcements facilitate communication between students and instructors.
- User Tracking and Reporting: Users' progress can be tracked, and various reports related to the course can be generated. This assists instructors in evaluating student performance.
- Gamification: By adding gamification elements to the learning process, Dokeos makes learning more engaging and motivating.
- Mobile Compatibility: Dokeos is optimized for mobile devices, allowing users to access educational materials from anywhere.

Components of Dokeos include course modules, exams, user management systems, reporting tools, communication platforms, and content management tools. It also supports e-learning standards such as SCORM and xAPI, enabling integration with external educational materials.

The advantages of Dokeos include its open-source nature, which provides a cost-effective solution. Its flexible and customizable structure means it can be extended to meet institutional needs. The user-friendly interface and comprehensive reporting features are significant advantages for instructors, as every stage of the learning process is trackable, and users' progress can be easily monitored. However, some disadvantages include limited community support compared to other LMS platforms and the potential challenges during the installation process. Additionally, more customization may require technical knowledge, which could be a barrier for small businesses. Dokeos is particularly suitable for educational institutions, universities, schools, and professional training providers. It is also an ideal platform for corporate training, especially for employee development programs and certification processes. Furthermore, governments and non-profit organizations seeking a low-cost yet comprehensive educational solution may prefer Dokeos.

## 3. Comparison of Learning Management Systems

Open-source LMS in educational technologies stand out due to their customizable structures, low costs, and extensive community support. These systems play a critical role in the digital transformation processes of educational institutions, particularly by offering flexible and user-friendly solutions. Platforms such as Moodle, Open edX, Sakai, ILIAS, and Canvas LMS are widely used worldwide, aiming to meet both technical requirements and pedagogical expectations of users. Additionally, alternatives such as Chamilo, ATutor, Claroline, Opigno LMS, and Dokeos cater to more niche needs, offering a broad range of users.

This study thoroughly examines the features, technical infrastructures, advantages, and disadvantages of open-source LMS platforms, providing an evaluation of their academic uses in different contexts. Furthermore, the technical competency requirements and potential user experiences of each platform are discussed to offer guidance for educational institutions. Technical details of the selected LMS platforms are included in Table 1.

**Table 1. Technical Details of Selected LMS Platforms.**

| LMS | # of Languages | # of Users | URL |
|---|---|---|---|
| Moodle | 100 | 143.000.000+ | https://moodle.org |
| Open edX | 32 | 14.000.000+ | https://open.edx.org |
| Sakai | 19 | 100.000+ | https://www.sakailms.org |
| ILIAS | 28 | N/A | https://www.ilias.de |
| Canvas LMS | 34 | 30.000.000+ | https://community.canvaslms.com |
| Chamilo | 3 | 12.000.000+ | https://chamilo.org |
| ATutor | 62 | N/A | https://atutor.github.io |
| Claroline | 35 | 5.000.000+ | https://www.claroline.com |
| Opigno LMS | N/A | 8.000 CO+ | https://www.opigno.org |
| Dokeos | 20 | 2.000.000+ | https://www.dokeos.com |

The open-source LMS platforms listed in Table 2 offer a variety of solutions tailored to different needs in educational technologies. The key features, technical infrastructure, and advantages of these systems are detailed in the context of user experience and academic success. Moodle and Open edX stand out with their flexible and highly scalable structures, offering robust analytical tools, while Sakai and ILIAS are more focused on enterprise-level applications. Canvas LMS is distinguished by its modern interface, while Chamilo and Claroline are noted for their ease of use. ATutor stands out for its prioritization of accessibility, whereas Opigno offers a modular structure with Drupal integration. Dokeos, on the other hand, is a suitable solution for small-scale institutions. However, each platform requires varying levels of technical expertise and community support, which may influence the selection process.

Moodle, continuously developed through the open-source community, offers an expandable platform [7]. Its modular structure enhances customizability with various types of plugins, although large-scale projects may require expert support due to

its technical knowledge requirements. Moodle is widely used, especially in universities and corporate training, and provides strong support for both group projects and individual learning. Open edX is particularly known for supporting MOOCs (Massive Open Online Courses). Its advanced analytical tools optimize student success tracking and reporting processes [8]. However, due to its Python and Django infrastructure, institutions may face difficulties in installation and maintenance. This platform is ideal for universities developing distance learning strategies and large-scale online courses. Sakai stands out with its enterprise-focused and customizable structure [9], making it suitable for integration with corporate applications due to its Java-based infrastructure. However, its outdated interface may negatively affect user experience. Sakai is used primarily in corporate and higher education settings and can provide an efficient collaborative environment, particularly for research projects. ILIAS, with SCORM compliance and comprehensive assessment tools, is ideal for institutions prioritizing standardized learning materials [10]. However, its smaller community support compared to other open-source projects may lead to delays in problem resolution. ILIAS, widely used in Europe, ensures the distribution of educational content in compliance with standards.

Canvas LMS (Open Source), although not as comprehensive as its commercial version, offers a user-friendly interface and modern infrastructure [11]. However, paid modules may be required for full functionality. This platform offers an effective LMS for universities and enhances student access through mobile compatibility. Chamilo has lightweight system requirements, allowing good performance even on low-resource devices [12]. However, its lack of advanced analytics and customization options may limit its use in large-scale applications. Chamilo provides a suitable solution for small-scale institutions and individual instructors. ATutor, with its compliance to accessibility standards, is particularly important for individuals with disabilities [13]. However, its lack of active development may limit its use in long-term projects. This system is suitable for accessibility-focused educational institutions and individual instructors. Claroline, with its simple structure, is suitable for basic-level educational management [14]. However, its lack of advanced features limits its support for complex educational processes. Claroline may be preferred for projects requiring less complexity or by novice LMS users. Opigno LMS, based on the Drupal platform, offers flexibility through its modular structure [15]. However, the need for Drupal knowledge may pose challenges for users lacking technical proficiency. It could be an ideal choice for institutions seeking customized solutions. Dokeos offers an e-learning-focused solution for small-scale institutions [16]. However, the lack of comprehensive features may be limiting for large-scale use. It provides an effective solution for smaller schools or individual instructors.

These systems cater to needs at different scales and, being open-source, offer customization opportunities. When selecting a platform, institutions should consider their technical infrastructure, target audience, and cost requirements. Platforms with strong community support, such as Moodle, Open edX, and Canvas, provide advantages for long-term projects.

**Table 2. Features of Open-Source LMS Platforms.**

| LMS | Key Features | Customizability | Supported Technologies | Advantages | Disadvantages |
|---|---|---|---|---|---|
| **Moodle** | Open source, strong community, modular structure | High | PHP, MySQL, PostgreSQL | Flexible structure, extensive plugin support | Requires technical knowledge |
| **Open edX** | Comprehensive analytics, MOOC support | High | Python, Django | Scalable, powerful analytical tools | Installation steps are complex |
| **Sakai** | Institution-focused features, flexible structure | High | Java, MySQL | Extensive community support, suitable for institutional use | Interface is not modern |
| **ILIAS** | Compliance-focused, SCORM support | Middle | PHP, MySQL | Comprehensive assessment tools, large user base | Limited community support |
| **Canvas LMS** | Modern interface, open-source version | Middle | Ruby on Rails, PostgreSQL | User-friendly, mobile compatibility | Some features available only in paid version |
| **Chamilo** | Quick installation, teaching-focused | Middle | PHP, MySQL | Easy to use, low system requirements | Lacks advanced analytics |
| **ATutor** | Accessibility-focused, modular structure | High | PHP, MySQL | Accessibility-compliant for individuals with disabilities | Development is inactive |
| **Claroline** | Simple and user-friendly | Low | PHP, MySQL | Easy to use, fast learning curve | Lacks advanced features |
| **Opigno LMS** | Drupal-based, flexible structure | Middle | Drupal, PHP, MySQL | Modular, Drupal integration | Requires Drupal knowledge |
| **Dokeos** | Suitable for small-scale institutions | Low | PHP, MySQL | Easy installation, e-learning focused | Limited comprehensive features |

Open Source LMS and Commercial LMS are two main types of LMS, each offering distinct advantages and disadvantages. Open-source LMS are generally cost-effective as they do not require licensing fees, and users can customize the software according to their needs. However, they have high technical knowledge and skill requirements, requiring expertise for installation and maintenance. Additionally, community support is generally available, but formal support services are limited. Security and integration may require additional effort and attention. On the other hand, commercial LMS typically offer more user-friendly interfaces, professional support services, and security guarantees. These systems cater to large-scale educational and corporate needs, with integration processes generally being smoother. However, commercial LMS may be more expensive in

terms of licensing fees and innovations, and may have some limitations in terms of customization. Both types can be suitable for different institutions and needs, but it is important to make a choice based on budget, technical capacity, and security requirements. Table 3 provides a comparison of open source LMS and Commercial LMS.

**Table 3. Comparison Between Open-Source and Commercial LMS Platforms.**

| | Open-source LMS | Commercial LMS |
|---|---|---|
| *Cost* | Generally free. Users can download and use the software, but they are responsible for installation, customization, and maintenance. Some open-source LMS platforms may offer paid services that provide additional features or premium support. | Some platforms offer limited free usage but require a license fee. This fee is typically charged per user or as an annual subscription. Additional features, custom reporting, and advanced support are usually provided for an extra fee. |
| *Customization and Flexibility* | Offers a high level of customization. Since the source code is open, users can modify the software to suit their needs and customize it to align with their workflows. | Typically offers more limited customization options. Commercial LMS platforms generally come with predefined features, and users have limited ability to modify or customize these features. However, some commercial solutions provide paid services for specific customizations. |
| *Technical Support* | Open-source LMS platforms typically provide community-based support. Users can seek help through forums and online resources, but there is no official support or guaranteed solutions. However, some open-source LMS providers may offer paid support services. | Commercial LMS platforms provide professional support services. They typically offer 24/7 support, training, and system management services. Users can seek assistance from an official support team to resolve any issues encountered while using the software. |
| *Security* | Security is typically ensured through community-driven development. Security patches and updates are identified and distributed by the community. However, more attention may be needed to address security vulnerabilities, and additional precautions might be required. | Commercial LMS platforms generally adopt a professional approach. These systems receive regular security updates and offer security guarantees. Additionally, commercial providers may implement more advanced encryption and data protection measures. |
| *Scalability and Infrastructure* | Typically the user's responsibility. Users who host their own servers may face additional resource and management requirements to handle high traffic. However, it is strong in terms of flexibility. | Primarily cloud-based, offering scalability for high-traffic usage. These LMS platforms are designed with infrastructure capable of handling large user bases and typically provide performance monitoring and optimization services. |
| *Integration* | Offers flexible integration options, but some complex integrations may require technical expertise. Most open-source LMS platforms provide plugins and modules to enable integration with external systems. | Provides a greater number of ready-to-use integration options and compatibility with third-party software. Integration with popular ERP systems, student information systems, and payment solutions is straightforward. However, additional fees are typically charged for integration services. |

# 4. Discussion

Open-source LMS are a crucial component of educational technologies, offering a wide range of solutions tailored to the needs of diverse user groups. The open-source nature of these systems allows institutions to customize them according to their requirements and provides long-term cost advantages. However, the effectiveness of these advantages and the contexts in which they become more beneficial reveal numerous factors that must be considered during LMS selection [17]. The technical infrastructure of these systems, community support, ease of use, and their impact on educational outcomes have been thoroughly discussed.

- Technical Expertise and Customization Requirements: Platforms like Moodle and Open edX stand out due to their high level of customizability. However, this flexibility often requires greater technical knowledge and infrastructure [18]. Specifically, Open edX may necessitate technical expertise due to its Python and Django-based architecture, making installation and maintenance processes more complex. In contrast, lighter LMS solutions such as Claroline and Dokeos, with simple infrastructure requirements, may be an attractive option for institutions with limited technical expertise. This situation compels institutions to carefully assess their technical capacity when selecting an LMS.
- Community and Support Factor: The success of open-source LMS platforms largely depends on community support [19]. Moodle, with its large global community, provides an advantage over other platforms when it comes to troubleshooting and developing new features. However, less widely used platforms like ATutor and ILIAS may present challenges for users in resolving issues due to the lack of community support. This highlights the critical importance of community backing for the sustainability of an LMS.
- User Experience and Accessibility: A user-friendly LMS significantly eases the adoption of the system by both teachers and students. Platforms like Canvas LMS (open-source version) and Chamilo receive positive feedback due

to their modern, user-friendly interfaces, while systems like Sakai, with older interfaces, fall behind in this regard. On the other hand, accessibility-focused platforms such as ATutor offer significant advantages for individuals with special needs. Such accessibility-oriented solutions are valuable for institutions aiming to implement an inclusive educational policy [20].

- Academic Success and Educational Outcomes: The impact of LMS platforms on student success depends on their capacity to deliver content that aligns with pedagogical goals and support learning processes through analytical tools [1]. Open edX, with its robust analytics tools, enables instructors to assess student performance effectively, while simpler solutions like Claroline and Chamilo are more limited in this respect. Furthermore, Moodle's flexible structure, which supports group work and individual learning, positively influences learning outcomes by encouraging active student participation.
- Scalability and Cost Management: It is crucial for educational institutions to select an LMS that meets their scalability needs. Platforms like Open edX and Moodle are effective in large-scale projects, whereas Dokeos and Claroline are more suitable for smaller applications. Additionally, despite being open-source, some platforms incur high technical maintenance costs, which can increase the total cost of ownership [21]. This necessitates careful consideration of long-term costs by institutions.

This study also addresses the various advantages and challenges of open-source LMS platforms. It is important for educational institutions to choose an LMS that aligns with their pedagogical objectives and technical capabilities. For example, Open edX and Moodle are recommended for large-scale MOOC projects, Claroline or Dokeos for smaller applications, ATutor for accessibility-focused needs, and Canvas LMS for those seeking mobile compatibility and a user-friendly solution.

The effective use of these systems should be planned to enhance digitalization processes in education and improve student success. Institutions should consider not only technical factors but also user experience and long-term sustainability when selecting an LMS. In this regard, the flexibility and customization options offered by open-source LMS platforms can be seen as a critical opportunity for the advancement of educational technologies.

## 5. Conclusion

Open-source LMS platforms emerge as a crucial tool in supporting the process of digitalization in education. Platforms with strong analytical capabilities, such as Moodle and Open edX, offer ideal solutions for large-scale distance education programs and MOOCs, while simpler platforms like Claroline and Dokeos provide fast and effective solutions for smaller institutions and individual instructors. Furthermore, modular systems such as ILIAS and Opigno LMS stand out as attractive options for institutions seeking compatibility and customization. However, when selecting a system, factors such as technical knowledge requirements, community support, system scalability, and pedagogical goals must be carefully considered. Educational institutions need to focus not only on the features of an LMS platform but also on its impact on student success, accessibility, and user experience. Open-source LMS platforms, with proper planning and integration strategies, can play a significant role in helping educational institutions achieve their digitalization goals. This study aims to contribute to decision-making processes in educational technologies by highlighting the capabilities of open-source LMS systems that cater to various user groups.

Future studies could explore the integration of advanced analytics and AI-driven tools in open-source LMS platforms to enhance personalized learning and predictive performance analysis. Additionally, research could examine the cross-cultural adoption of LMS platforms, considering linguistic and pedagogical variations in diverse educational contexts. Longitudinal studies measuring the sustained impact of LMS platforms on academic performance, retention rates, and student satisfaction would provide valuable insights. Investigating the scalability and feasibility of deploying these platforms in resource-limited settings, with a focus on technical and financial constraints, could address critical challenges. Furthermore, evaluating the effectiveness of collaboration tools in hybrid educational models that combine online and face-to-face instruction would contribute to optimizing learning outcomes and system utilization. These directions aim to fill existing gaps in the literature and enhance the academic and practical contributions of LMS research.

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