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1. What is an LMS?

The term Learning Management System (LMS) refers to a software application for the administration, documentation, tracking, reporting, and delivery of educational courses, training programs, or learning and development programs. LMSs are also called (mostly in Europe) Virtual Learning Environments (VLEs).

Actually, an LMS or VLE is a web-based platform for the digital aspects of courses of study, usually within educational institutions. It allows participants to be organized into cohorts, groups and roles; present resources, activities and interactions within a course structure; provide for the different stages of assessment; report on participation; and have some level of integration with other institutional systems.

Typically, an LMS provides instructors with ways to create and deliver content, monitor student communication and participation, and assess student performance, and provides students with the ability to use interactive features such as threaded discussions and video conferencing.

We can think of a Learning Management System as technology that can improve learning, make it faster, productive, cost-effective, and what is more important - trackable. The most basic LMS contains a core functional platform that enables administrators to upload learning content, deliver lessons to students, serving notifications, and share data with authorized users. An LMS most often operates inside of a web-browser, behind a secure sign-on process. This gives all students and instructors easy access to courses on-the-go, while administrators and leaders can monitor student progress and make improvements.

There exist a vast number of bibliography on Learning Managements Systems. Many online courses are available too. For an introduction to LMSs one can see (Chapman, 2011). An overview on them is given in (Turnbull, Chugh, & Luck, 2019).

2. Types of LMSs

There are several types of Learning Management Systems (“What is a Learning Management System | LMS Overview [2020],” n.d.). An organization or university, can choose the type that best fits its need.

Enterprise vs. Individual

An enterprise learning solution is generally customized for a large company of 500 or more employees. It's highly scalable and can be designed to grow with the company and as new courses are added. Oftentimes, an enterprise LMS has a huge list of built-in features to fulfil any needs that may be required.

On the other hand, an individual or small organizational LMS may offer few or all the features available, but limits them to what an individual course producer may need. However, this can serve the small organization or individual person to produce various learning materials. Often LMS providers offer different subscription plans to fulfil different needs, so a small organization can utilize the LMS for its needs, and for an appropriate price.

Free vs. Commercial

There are dozens of free, open-source e-learning products for individuals to build courses for their learners. Anyone who has knowledge can deploy it and create a course that can be accessed via an e-learning environment. Many free LMS also offer advanced levels and a big list of available features. The main problem of a free LMS is that they don't have the level of support that some users are accustomed to. For this purpose, specialized administrative and technical stall must be deployed or hired.

On the other hand, a commercial product is designed to be used by any organization, a college or university, or another educational primary organization. It's generally easy to deploy and it has 24/7 support. It also comes with a price tag depending on the level of required features. Mostly commercial platforms need frequent updating, but they also provide an increasing list of available features, so you always will be using the most modern hi-tech e-learning solution.

SaaS vs. Licensed Product

Perhaps the most popular model for an LMS, is the software as a service (SaaS) model. It's a ready-out-of-the-box solution that's easy to deploy. Usually its Cloud-based, and includes frequent free upgrades. While it can be somewhat limited in customization, a SaaS LMS is perfect for the organization that's growing because it's scalable over time. Moreover, technical support is generally included for the entire use period.

A licensed learning management system can offer the ultimate in customization, customer support, and reliability for users. It is more flexible and built to each customer's specifications, which may take some time. It can be installed on a cloud server or on-premise. Implementation can happen when the organization chooses, but updates may take more time. The largest cost is the user license, however, licensed products win in a long distance, especially if they

are implemented as a cloud-based solution. This makes the cost of ownership and cost per user significantly lower as compared to SaaS solutions. Support can be limited by time or included as a premium paid add-on.

Cloud-based vs. On-premise

A cloud-based LMS is hosted on a secure off-site server and allows users to access the product using a variety of computers and mobile devices, even offline using an app. It can include many of the most popular features that learners expect. A cloud-based LMS is much more scalable as compared to an installed version.

Built as a stand-alone product, the on-premise LMS is a licensed product built and installed to the organization's specifications on the server of their choice. It can be limiting, on a big scale you have to use several servers. A cloud-based installation can be more cost-effective in some cases. On-premise installation maintains user and corporate data on a highly secure basis.

Integrated

Modern LMS takes into consideration the existing software and systems that the organization has in place, then blends in with them for a seamless user experience. Integration involves connecting the LMS with other compatible products to enhance the learner experience. Of course, the organization may choose to keep the learning management system completely separate from all other systems and products. However, this disables some of the opportunities that this integration can involve.

Built-in Authoring Tools or Pre-Written CMS

Most modern LMS includes content authoring tools or supports The Experience API/xAPI (or SCORM) standard and allows developers to upload already created courses and lessons from authoring tools or LCMS/CMS. In general, courseware developers prefer having access to built-in authoring tools that enable full course creation and revisions. In most cases, even pre-authored content can be included and new modules, exercises, learning documents, assessments, and more can be integrated.

Often confused with LMS, a content management system (CMS) is a different product. However, a CMS can be used to house some learning materials and project documentation. It can also be a good place for L&D teams to work out course design well ahead of the roll out of real courses. However, it is no substitute for an LMS. Pre-written course lessons can be developed here and imported into the LMS at a later date.

3. LMS features

As summed up in ("What is a Learning Management System | LMS Overview [2020]," n.d.), a Learing Management System should be able to:

- Provide learning experiences that are adapted to individual learners
- Make it easy for instructors to make notes and changes
- Give instructors and students the opportunity for online collaboration
- Integrate common tools such as calendars, word processors, and more
- Create a corporate culture-sensitive, branded presence for learners
- Include insights into user progress through built-in analytics
- Be able to scale globally as the organization grows

A modernLMS often has built-in tools and resources that help administrators to develop course lessons, activities, and assessments. Administrators can assign new user credentials and schedule courses to be completed. They can also track learner progress with reporting features.

Moreover, a good LMS helps to make learning interesting, engaging learners so they take a more active role in their own development. An LMS should be simple to access and use in order to encourage learners to participate. The design of the LMS should be friendly in appearance and functionality -- based on user requirements.

There is a number of common features that an LMS for education should have, based on students' learning requirements ("Best LMS for Schools - 2021 Reviews," n.d.):

- Course creation: Helps teachers and administrators create online courses for specific subjects by generating content, course completion timeline, and assignments.
- Online quizzes: Lets teachers create quizzes to increase engagement and test student knowledge.
- Online assessments: Helps teachers administer online tests and exams by generating test questions and assigning scores for each, then automatically calculating students' total scores.
- Reporting dashboards: Provides teachers and students with an overview of all test scores and grades in a specified period.

- Mobile-based learning: Provides multi-device support so students can view course materials and assignments on smartphones and tablets.
- Virtual classroom: Lets teachers and administrators set up and teach remote classes through video conferencing.

4. LMS Tools

In ("Unit 2 | Introduction to Learning Management Systems (LMS) – Teaching Online: Basic Skills for TAs," n.d.), a number of LMS tools and their definitions followed by some examples of how they might be used, is summarized. These tools are not always available in all LMSs and their usage may vary. Tools are grouped into categories and a short description of each tool is given.

Assessment Tools

- Blog: Allows students to document their learning experiences chronologically, share it with the instructor and classmates and provide feedback to one another.
- ePortfolio: Allows students to create a personalized web space with all their best work.
- Journal: Allows students to document their learning and share it with the instructors only.
- Quiz: Allows instructors to assess student learning by creating various types of questions (e.g., multiple choice, true/false, short answer).
- Self and peer assessment (aka Workshop): Allows instructors to use student self-assessment and peer assessment.
- Wiki: Allows students to create and edit content pages as a group.

Communication Tools

- Chat: Allows students to synchronously talk to each other using text in a virtual chat room.
- Discussion Forum: Allows students to asynchronously comment using text or audio in a forum-type environment.
- Email / Internal email: Allows students to send emails while they are navigating the course content in LMS.

- News: Allows instructor to send course announcements.
- RSS: Allows students to subscribe to course updates. They will be notified via email when changes are made to content pages.

Content management / organizing Tools

- Calendar: Display all the important events (e.g., assignment due dates) in a calendar format.
- Checklist: Allows instructors to create checklists for students to proceed with their learning.
- Competencies: Allows instructors to create competencies for a course or program and monitor student achievement.
- FAQ: Allows instructors to create pages in a “frequently asked question” format.
- Glossary: Allows instructors to organize content in a glossary format.
- Lesson/Module: Allows instructors to organize content in sections, learning modules or units.
- Rubrics: Allows instructors to create rubrics.
- SCORM: Allows instructors to upload SCORM content/objects.

Data Collection / Reporting Tools

- Survey / Feedback: Allows instructors to survey students and collect information/feedback.
- Assignments / Dropbox: Allows instructors to assess student learning and provide feedback to their assignments.
- Grade book: Allows students to see their grades.

As you will realize, more than one tool may be used for the same teaching purpose. For example,

- Using weekly discussion forums, each student could be expected to post their answers to the discussion forum and read and respond to others’ comments.
- In a blog or journal, the student could keep a record of their responses to the questions and invite peer review from classmates.

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- In assignments or dropbox, the responses to the questions remain private between the instructor and the student.
- In the text box quiz function, the student has a limited time to privately respond to the questions.
- In a wiki, students could write multiple edited responses to the questions until they have reached consensus on the “correct” or best answer.

The online course author would have selected a specific tool based on a number of criteria, including:

- alignment with course outcomes,
- ease of use for both student and instructor,
- method of marking,
- convenience,
- synchronous vs asynchronous communication, and
- individual or group related work.

5. LMS benefits in Education

Learning Management Systems are being extensively used in schools, colleges, universities and of course organizations. These include Computer-Based Training (CBT), Web-based Training (WBT), on-line or blended learning continuous on-line assessment and management of training, collaborative learning i.e. application sharing, discussion, Web seminars and training resource management, etc. Things like managing instructors, facilities and equipment are also some of the features of Learning Management Systems.

In a recent study, most of 50% of participants prefer on line courses, due to existing commitments such as jobs, family, and others. LMSs allows schools and universities to deliver more courses and resources using less funding demands and different delivery models, in order to face such challenges and fulfill students’ needs. Moreover, LMSs provide instructional designers and course developers with valuable insights and tools to optimize operations and adjust courses in order to improve learner’s engagement, facilitate collaboration and more.

We next give some of the benefits of using an LMS in education (“Best LMS for Schools - 2021 Reviews,” n.d.):

- Create courses based on your school's learning requirements. LMS tools help schools cater to their specialization by letting teachers create courses with the help of a course-authoring feature. This feature lets teachers create chapters, add multimedia content, and include assessments from predefined templates.
- Improve student learning experience. With the help of interactive multimedia content (e.g., videos, animation, graphics), students can enjoy their learning experience by using an LMS designed for schools.
- Monitor student performance in a centralized dashboard. Learning management tools for schools save teachers time by pulling student performance data into a centralized dashboard, eliminating the need for manual record-keeping. Advanced dashboard filters allow users to view scores individually or collectively.

The general benefits of learning management systems, as listed in (Turnbull et al., 2019) include:

- Access learning on the go: Easy accessibility via any mobile device to capture opportunities for learning
- Flexibility in learning pathways: Ability to set up specific learning pathways for students and training plans for adults
- Use a variety of learning materials: Bringing together learning materials from a wide range of sources, from MOOCs to user-shared materials
- Analyze learning patterns: Analytics that provide a progress report of every user and proof of knowledge
- Learning Automation: Automation of many learning processes, including scheduling, invitations, and follow-up support

Moreover, as listed in (“Introduction To Learning Management System,” n.d.), the benefits of a Learning Management System are:

- It is easy to use and very effective.
- It allows the organization to deliver quality e-Learning to the entire team without any hurdles.
- It is cost effective when compared to traditional training methods.
- Tracking, managing and reporting learner’s progress is just keystrokes away with the Learning Management System.
- It is a simple, lightweight, efficient, compatible, low-cost training interface.
- Site colors, fonts, and layout may be customized for individual trainees and trainers.

- Session listing shows descriptions for every teaching module on the server, including accessibility to them.
- Saving the time of the personnel, as he can access the training from his house, office or laptop. No rescheduling of program necessary.
- Access to customized training i.e. specific training given to a specific individual reduce time spent on training and gives higher ROI.
- Management of users, roles, courses, instructors, facilities and generating reports becomes easier.
- Learner messaging and notifications possible to remind them about training and answer queries.
- Assessment/testing of students pre/post training is made easy and efficient.
- Records and plays class transcripts etc. All sessions are recorded for later viewing as well.
- Flexible array of course activities – Forums, Quizzes, Glossaries, Resources, Choices, Surveys, Assignments, Chats, and Workshops to choose from.

6. Popular LMS in Education

We review next a number of popular Learning Management Systems used in education, as listed in (Bouchrika, 2020). More LMSs and comparisons of them can be found in ("Best LMS for Schools - 2021 Reviews," n.d.) and ("17 Best Learning Management Systems (LMS) of 2021Ranked," n.d.)

Moodle is a free and open-source learning platform that has been around for quite some time. While it does not look as modern or as sleek as paid competitors, its robust functionalities make it a great option for any academic institution. The LMS is fully customizable and extensible to perfectly fit your needs. The thousands of community-developed plugins will also allow you to add new functionalities. Furthermore, it seamlessly integrates with solutions like NextCloud, Google Apps, Microsoft Office 365, and more.

Blackboard is one of the most popular names in the digital learning market. The platform comes in both software-as-a-service (SaaS) and non-SaaS models. The service provider offers all core learning management features as well as powerful data analytics, communication channels, collaboration tools, and web conferencing. Class facilitators can

easily deliver homework, tests, and track grades. They can also manage online and blended classes.

Schoology is another fully-featured learning platform that aims to provide all the tools that you need to design lessons, communicate with students, and collaborate with educators. Its strength lies in its focus on building and connecting your learning community from students to administrators. What's more, it not only includes class-level channels but also allows you to connect your entire school. This way, you can create online spaces where students can engage with their teachers outside class hours.

Google Classroom is a free part of the Google Suit for Education. It helps teachers create classes, send assignments, communicate with students, grade coursework, and post feedback all in one place. It also streamlines repetitive tasks so educators can focus on teaching. With its Material Design, everyone can sign-in on any device using any modern browser. Google Classroom is also available on Android and iOS for students on-the-go. While it is not as comprehensive as other LMS, its integration with the rest of Google products makes it a powerful platform.

Canvas by Instructure is a popular learning ecosystem among colleges and universities. The LMS is part of its digital learning solutions that include powerful course assemblers, dashboards, test engines, and more. The platform's modules allow educators to organize course work and content into units. The Outcomes feature combines state-wide assessment and grading rubrics that allow administrators to align with existing standards. It even includes a comprehensive assessment management function specifically for K-12 school districts. The LMS also includes Gradebook and SpeedGrader, two of the most flexible and efficient grading tools in the market.

Desire2Learn Brightspace is one of the first LMS and still remains as one of the most well-known platforms around. It is perfect for institutions looking for solutions targeted towards blended learning and competency-based education (CBE). CBE courses let students demonstrate their skills and allow them to attend a custom set of courses based on their competencies. The Brightspace ePortfolio is a customizable feature where students can upload, organize, share, and reflect upon their work. Combined with the Prior Learning Module, the platform determines the students' strengths and weaknesses for a tailored learning experience.

Absorb LMS was developed for large enterprises, small and medium businesses, and public institutions. It is also perfect for schools and universities looking for a holistic learning

management system. Its core features are designed around a fast-paced learning environment while maintaining engagement and better outcomes. Aside from creating your own courses, Absorb LMS includes extensive eLearning Content Libraries. These pre-made online courses allow you to publish classes right away. It also comes with powerful features such as smart administration, learner engagement and experience modules, integrations, and mobile applications.

LearnDash is a robust WordPress plugin that allows you to create, manage, modify, and publish classes right in the popular content management system (CMS). Its powerful course builder is easy to use with its drag-and-drop layout. You can create multi-layer courses and even reuse content from one class to another. The plugin also includes a Focus Mode that lets your students focus on the coursework. It also comes with functionalities such as drip-feed content, GradeBook integration, certificates, badges, and much more.

CertCentral is perfect for institutions that offer certificate training programs and continuing education. Its seamless interface allows efficient course development and certifications. The drag-and-drop layout allows you to quickly create content and customize it for various courses. Aside from the core LMS features, it includes advanced functionalities such as enhanced testing, custom certificates, compliance and security, and reporting and analytics. It also integrates with Stripe so potential students can subscribe to courses right away.

Edmodo LMS aims to bridge teachers, students, parents, and administrators in one platform. These academic participants can create posts and messages using the built-in communication tool that resembles a social media platform. Teachers can create content, quizzes, and other digital assets. They can even share resources with other educators. Students will enjoy the built-in planner that syncs with all their classes, including course content, tests, and more. Parents also have access to their children's grades and scores in real-time. They can easily get in touch with teachers to ensure that they are always in sync.

7. How to choose an LMS

In ("Best LMS for Schools - 2021 Reviews," n.d.), there were given some of the most important core functionalities that a school or university should consider when choosing an LMS.

Student and Teacher Collaboration

Using a new model of teaching through LMS entails different styles of collaboration that are not usually seen in a typical classroom setting. It includes features that facilitate easy and seamless collaboration between teachers and students.

A real-time communication platform should be included, such as chat or integration to a VoIP service. This allows teachers to talk to the students while conducting live video or audio classes. Similarly, everyone should also have access to asynchronous communication, such as forums or conversation threads. This way, class members can post messages and replies, even outside class hours. Additionally, a one-to-one communication channel should be available as well for teacher-student consultations.

More importantly, these features should be contextual. That means class facilitators should be able to post topics for discussion, course materials, or assignments where students can also ask questions and other concerns. This makes it easy to track, moderate, and monitor conversations.

Quizzes and Tests

Any robust LMS should have a built-in quiz or test engine. Because educators are not physically present, they cannot ensure that students are religiously fulfilling their coursework. The only way they can properly evaluate the students is through assessment. Unfortunately, while uploading a word file with questions can do the task, it is not efficient.

Facilitators should be able to create questions that can be saved into a “bank.” Additionally, they should be able to create questions of different types, from multiple choices to essays. Each type should have a layout that can be easily understood by students.

Furthermore, teachers should be able to mark items as correct or wrong easily. Better yet, the test engine should be able to check the students’ work and compute the score with its associated grading rubric. For essay-type tests, teachers should have a way to provide reviews or feedback. Some LMS also have the ability to limit the attempts to take the test, randomize questions, or set a timer for specific questions.

Having these smart solutions in creating and providing evaluations will allow educators to develop creative questions that will test the students’ critical thinking and other skills. Objective quizzes where participants just memorize facts are not ideal for such settings as answers can be searched on the Internet and other resources. Hence, the time saved from using such solutions will ensure that teachers can work efficiently while providing high-quality education.

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Data and Reports

Having classes and courses conducted using an LMS provides an opportunity to collect data that are otherwise difficult to gather in a classroom. Reports can be generated from this information to provide you with insights. The following reporting features should be natively available in an LMS:

- Test scoring and assessment throughout the course
- Student progress reporting through materials and course
- Course time tracking (for self-paced classes)
- Course feedback from the students
- Facilitator and teacher assessment by students
- Student engagement and participation

These reports should be generated in just a few steps, or better yet, automatically.

Mobile Access

An LMS platform should be accessible using mobile devices like smartphones or tablets. It should adapt a responsive design, so the web portal is much more flexible. Or, a mobile version of the LMS should be available for a more optimized experience.

The mobility also allows students to access course material using cellular data. The flexibility allows schools and universities to offer courses even to those outside the reach of wired Internet connections. Participants with hectic schedules can also access online classes at their convenience.

Needless to say, the perfect LMS will depend on the type of academic institution, classes, student demographics, and faculty members. Open-source solutions like Moodle provide the most flexibility, but you will need a competent developer to get it running. Google Classroom and Edmodo LMS are perfect for K-12 programs with their ease-of-use and accessibility. On the other hand, Absorb LMS and CertCentral fit institutions that offer training and certifications for continuous learning.

8. Learning Analytics

Learning Management Systems records all users' actions such as login/logout data, number of assessments completed, and activity in discussion boards in a log record in a database with a predefined schema. This log file can give feedback about students' activity, attention, active

participation and engagement. By analysing this large amount of valuable educational data provided by LMS, one can make the right decisions and enhance the teaching and learning process. Moreover, this information, combined with students' administrative data, can give a holistic view of student performance and tutor effectiveness, and provide knowledge to empower students learning and tutors teaching experience, as well as enrich educational process and elevate the level of academic excellence.

Educational Data Mining, or Learning Analytics is a recent field of data science where data analysis techniques have been applied to higher education for identification of meaningful information from large datasets. In (Long & Siemens, 2011), Learning analytics (LA) is defined as "*the measurement, collection, analysis and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs*". Within an LMS, LA techniques can analyse the large amount of educational data that have been produced by students' interactions and have been collected from the logging utility of the LMS. The analysis results can be easily visualized by external tools that were developed to allow the graphical visualization of several aspects related to students and tutors' accesses in virtual learning disciplines, thus helping tutors to better follow teaching and learning process, as well as to visually identify lagging behind or at-risk students, or to better understand how the different educational resources are being used. By this way, "*Learning Analytics is essential for penetrating the fog that has settled over much of higher education", from the perspective of tutors, learners, and administrator and decision-makers*" (Long & Siemens, 2011).

One can perform an external analysis of educational data by downloading logs from LMS and next apply data mining and visualization techniques. Another approach is to use LA, for collecting, analysing and visualizing the results within the LMS in dashboards. A learning analytics dashboard (LAD) enables teachers and students to monitor and reflect on their online teaching and learning patterns. In Moodle, LADs are external plugins that were contributed by the Moodle community and extend the services offered by the learning environment. We next shortly present some popular LADs that aim at visualizing students' activities and facilitate students and tutors to have a quick and direct view of their performance, and in turn, to assist them to make the right decisions to improve their educational process.

The Completion Progress is a color-coded progress bar for students and teachers. It visually presents the activities and resources with which the student is expected to interact in a course, based on the course requirements. Different colors indicate the activities and resources that students have or have not completed or viewed. The green color corresponds to completed

activities or resources while blue color to future not-completed ones. There also exists the yellow color for the submitted but not completed ones, and the red color for the non-completed ones. The ordering of the activities and resources can be based on expected completion times or on the ordering of activities in the course.

The Forum Graph processes data from a single forum activity in a course, analyze the interactions between students and teachers and create a directed graph. Nodes represent participants, colored with different colors for teachers and students, while edges represent the interaction among the participants. The size of each node depends on the number of messages the participant posted, while the thickness of an edge indicates the number of replies and the arrow defines who was replying.

The Analytics Graphs is a descriptive tool that provides numerus graphs that can be used to facilitate the identification of students' profile, in order a teacher to make the right decisions and enhance the teaching process. By clicking on a graph element, the teacher can immediately communicate with a student or a group of students, according to their performance, by sending an email to them. Analytics Graph could be used in the first weeks of a course to increase student study engagement and consequently to reduce dropout rates.

Configurable Reports is a custom report builder, appropriate for administrators or teachers to create reports. Reports are customized using SQL queries and can be viewed by selected users. Non-expert users, like teachers, can easily create some kind of reports, however for more complex information, knowledge of Moodle database schema along with an expertise on design and development SQL queries is required.

The Course Dedication allows to see the estimated dedication time to a Moodle course by the participants of the course. Teachers can use this tool to analyze dedication time within a course. Dedication time is estimated based in the concepts of Session and Session duration applied to Moodle's log entries. This block is intended to be used only by teachers, so students aren't going to see it and their dedication time.

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