

An Analysis of Some Learning Management Systems

Radoslava Kraleva^{#1}, Mehrudin Sabani^{#2}, Velin Kralev^{#3}

[#]Department of Informatics, South-West University "Neofit Rilski," 66 Ivan Michailov Str., Blagoevgrad, 2700, Bulgaria
E-mail: ¹rady_krleva@swu.bg; ²sabanimehrudin@outlook.com; ³velin_krlev@swu.bg

Abstract— The use of modern information and communication technology as a means of training pupils and students has become a popular trend. For this purpose, a special type of web-based content management systems, called Learning Management Systems (LMSs), has been used. Due to their wide implemented, lots of LMSs have been developed in recent years. All those platforms often provide similar features and users can hardly choose the most appropriate for them. There is a variety of methodologies for the quality evaluations of e-learning in the scientific literature. However, there are no good explanations and detailed studies of most of the modern LMS platforms. This article proposes an analysis of the usability and software functionality of the LMS frameworks. Based on the survey of the state-of-art science research, the criteria for analysis of the LMS platforms in this paper are summarized in three categories: Learning skills tools, Communication tools, and Productivity tools. The main goal is to present a wide-range comparative analysis of 36 electronic learning management systems. All of them support the use of multimedia elements, creating and editing the lectures, exercises and course assignments. The lack of communication support leads to using web forums and social networks out of the LMS. The contribution of this paper presents an enriched modern trend of the software methodologies of the web-based oriented learning management systems from the perspective of design and development.

Keywords— e-learning; learning management system (LMS); LMS analysis and evaluation; human-computer interaction; software engineering; mobile learning.

I. INTRODUCTION

The standard classroom, paper textbooks and paper handouts are no longer the only way to teach and educate students. The development of information and information technologies has provided an opportunity for their direct use in the training process. New types of training such as e-learning, distance learning and mobile learning have emerged [1]. All of them use the internet to provide the necessary training materials and are often named only web-based e-learning. According to [2], e-learning provides asynchronous interaction, at any time, in every place, assists in teamwork and contributes to the use of new technologies in education.

Moreover, this type of learning is a model of the modern education system which aims to cope with the rapid development of information technology and to motivate young people to learn. The increasing motivation of the student to learn new knowledge and to get new skills through LMS has been noted in several scientific publications [3]–[5]. Using LMS platforms on every phone, tablet or laptop in every place and anytime, supports to the students to learn more easily, to be more interested and freer in the learning process.

For example, in a traditional classroom, educators try to keep the attention of the learners throughout the learning process. Nevertheless, students do not always respond to the questions, and they are not often focused. Sometimes simply because they distract, but sometimes because they do not understand the taught material. This lack of engagement is a challenge for both the teacher and the student. The speed of assimilating new knowledge is an individual process. Students often want to ask their teachers to stop and re-explain what they have not understood, but they do not do that. This leads to significant deficiencies in the students' knowledge, and hence to their inability to learn the subsequent material.

What is necessary for interesting and useful learning is to develop proper teaching materials that can be easily updated and maintained. They should allow the use of different types of multimedia and access from different devices. The main function of the software application named web-based Learning Management Systems (LMS) is to provide a safe, reliable, and flexible e-learning environment. This specialized software is primarily aimed at training and allows the creation and maintenance of learning content and organizes it in a standard way as a course divided into modules containing lessons, automatically generated tests with questions from pre-created urns, and support for the track progress of the learners [6]. The supports for chats,

forums, wikis and e-book libraries are also part of the current LMS specification.

Using the e-learning platforms provides the teachers and learners with a flexible tool that is accessible at any time and from anywhere. E-learning materials can be easily re-written or/and upgraded, and the student can quickly and easily get in touch with their teacher and get the help they need without being worried by their peers. More and more education ministries encourage teachers to use e-learning platforms to motivate their students [7]. Moreover, many of the universities and schools use LMS platforms to complement face-to-face learning. All this determines the widespread distribution of such software.

Over the last years, various LMS platforms have appeared. They have different functionalities and give users a variety of options. Some of the modern LMS systems are based on cloud computing and do not require a system administrator with experience in software installation and support. But there are also systems where in-depth knowledge of web programming languages such as PHP, JavaScript, knowledge of management and administration of databases, such as MySQL, Microsoft SQL Server, is strictly necessary.

Over the last few years, the most interesting approach to software development has been the one based on the users' preferences and experiences, called user-centred design [8], [9]. This method gains increasing popularity among software developers and has a direct impact on end-to-end software, including those designed for learning [10].

The centre attention of designers and developers of LMS platforms adapted to users' capabilities and preferences is reviewed in [11]. Chang and Guetl discuss the challenge of life-long learning and the shortcomings of modern e-learning systems. The focus of their study is the use of different pedagogical approaches and learning tools.

A new kind of e-learning system based on automatic recognition and prediction of user preferences and self-adapting to the user requirements has emerged recently. This type of system is called the Adapting Learning Management System [12], and its development and improvement are forthcoming. Other researchers are directing their efforts towards e-learning based on social networks and enhancing communication between learners (students) and trainees (lecturers) [13], [14]. The use of social networks as an e-learning platform is also studied in [15].

One should not ignore that the LMS systems are like black boxes for end-users which people choose only because of their price and personal preference. In most cases, they choose the software that they have already used, or it has good reviews, and they would hardly replace it with a different LMS framework, regardless of its qualities and capabilities. In most studied articles, scientists have proposed evaluation models for LMS platforms, but they have analysed with them only 3 applications. The present study shows that there is a lot of e-learning software, and most of them have similar characteristics.

This article reveals the conducted comparative and analytic empirical study of web-based Learning Management Systems platforms based on our approach of evaluating the e-learning platforms quality in terms of their software specifications and functionalities. The main goal of the study is to present the current trends in the LMS platform

development. The obtained results should be helpful for the future design and development of the e-learning software.

II. MATERIAL AND METHOD

Investigating the quality of education after using e-learning systems has been the subject of many studies. A significant part of the researchers proposes different approaches and criteria for evaluations of LMS platforms based on their applying and use in the learning process.

One of the first studies related to evaluating the e-learning platforms quality was provided by Ehlers in [16]. He defines "that a learning environment can be conceptualized by four different components that each embedded different perspective on quality": (i) Learner, (ii) Learning Environment, (iii) Goal and Intention, (iv) Topic and Content.

The advantages of using e-learning are undeniable and have been the subject of extensive discussion and research by various scientists and educators over the past decade. In a study among 424 students, Liaw [17] found that using interactive multimedia education has contributed to improving the effectiveness of learning. The importance and advantages of multimedia elements are presented in [18]. That is why many of the modern e-learning systems provide the opportunity to create interactive multimedia resources, and this opportunity should be considered when creating criteria for evaluation and analysis of LMS frameworks.

The advantages of Moodle LMS used at the Gokaraju Rangaraju Institute of Engineering and Technology (GRIET), Hyderabad, India, was extensively studied in [19]. Madhavi et al. are noted that 100% of the students used this e-learning system in classrooms, and they continued to learn actively outside the institution. This further reinforces the close relationship of the information technologies in the area of education and raises interest in the education of young people.

The effect of LMS platforms as a pupil-to-pupil and student-to-student communication and as a place to share information and knowledge in a closed group has been dealt with in [18].

The trend towards a steady increase in the scientists' interest in e-learning and all its variants based on the analysis of available documents from Scopus database until 2019 is reported in [20]. An analogous study of E-learning, M-learning, D-learning related to their definitions and analysis of their importance in 260 scientific papers is presented in [21].

Other studies are discussing the negative impacts of e-learning environment such as diminishing the interest of learners, reduction of the communication between the lecturer and students, the need for good self-discipline, and responsibility to the learning process [22], [23]. Interestingly, these publications are much fewer. It has led to a change in many educational systems around the world, including in Bulgaria. Currently, blending learning is applied to lots of Bulgarian schools. LMS platforms are used to support classical learning. In lots of Bulgarian universities, distance learning is widely used.

TABLE I
FACTORS AND EVALUATION CRITERIA OF THE LMSs ACCORDING TO SOME STUDIES PUBLISHED DURING 2004-2019.

Author(s) and references	Factors and evaluation criteria of the LMSs according to the cited references
U. D. Ehlers, 2004 [16]	<i>Tutor support:</i> Interaction centeredness; Moderation of learning processes; Learner vs. content centeredness; Individualized learner support; Goal vs. development centeredness; Traditional communication media; Synchronous communication media; Asynchronous communication media <i>Cooperation and communication in the course:</i> Social cooperation; Discursive cooperation <i>Technology:</i> Adaptivity and personalization; Synchronous communication possibilities; Availability of contents. <i>Costs - Expectations - Value:</i> Expectation of individualization and need orientation; Individual non-economic costs; Economic costs; Practical benefits; Interest to the course and media usage. <i>Information transparency:</i> Counselling, Advice; Organizational information; Information about course / contents. <i>Course structure:</i> Personal support of learning processes; Introduction to technical aspects and to the content; Tests and exams. <i>Didactics:</i> Background material; Multimedia enriched presentation material; Structured and goal-oriented course material; Support of learning; Feedback on learning progress; Individualized tasks
F. B. García and A. H. Jorge, 2006 [32].	<i>Content:</i> Content authoring; External sources; Multimedia contents; Multiple organizations. <i>Communications:</i> Forums; Messages; E-mail; Chat. <i>Management:</i> User/groups; Assessment; Grades; Tracking.
Å. Grönlund and Y. M. Islam, 2010 [36]	<i>Learning and communication tools:</i> Self-assessment quiz; Questions during class; Participatory cards; Homework; Learning partner; Meaning; Reading <i>Administrative tools:</i> Registration; Attendance; Course information & rules; Results <i>Teacher support:</i> Live lesson; Dashboard for the teacher; Analysis of student responses
P. Poulova, I. Simonova and M. Manenova, 2015 [26]	<i>Tools intended for generating contents:</i> Page; URL; File; Folder; Legend; Book; Lecture; Dictionary (index); Syllabus; Lesson plan; Video; Integration (integration with study contents of other LMS). <i>Communication tools:</i> Discussion panel; Chat; Reports; Inquiry; Comments; Blogs; Survey (question-form). <i>Tools for collecting and evaluating activities:</i> Task; Test; Workshop (Self and Peer Assessment); Safe Assignment. <i>Tools for co-operation and other possibilities of the system:</i> Group mode; Wiki; Virtual classroom; Calendar; Internal mail; Tracking; Statistics; Database; Language adjustment; Certificates. <i>Price.</i>
N. N. M. Kasim and F. Khalid, 2016 [24]	Based on the Cloud; Flexible; Easy to use; Able to integrate with other systems; Accessible; User-friendly; Synchronous and asynchronous interaction; Able to see who is online; Personal space for draft writing and journals, as well as managing personal and private information; Able to send and receive personal messages with other users; Lecturers and students able to adapt and manage the courses in the software; Each user has file storing utility and the storage can be shared with other users; The entire content and course structure can be stored and backed up in the software; An administrator can restrict user access or give multiple roles to multiple users; Provides contextual learning, able to identify talent, improve the efficiency and effectiveness of workforce management
A. Janson, M. Söllner, and J. M. Leimeister, 2017 [28]	IT support; Interactivity; Task-technology fit; Faithful LMS appropriation; Learning process satisfaction; Perceived learning success
M. Ouadoud, M. Y. Chkouri, and A. Nejari, 2018 [29]	<i>Learner support:</i> Pedagogical activities: problems, simulations, tests self-correcting; Interactive resources: text, image, audio, video, PDF, Flash; Assessment; Collaborating learning with sheared documents <i>Teacher support:</i> Creating the teacher recourse interfaces; Sharing educational resources; Planning of pedagogical resources. <i>Tutor support:</i> Creating and management of the forums, chat and videoconference; Monitoring of the students' activities; Monitoring the groups' management. <i>Administrative tools:</i> Establishing the groups; Monitoring the activities of teachers; Managing the courses; Customizing the platform; Managing the roles.
R. Kraleva and V. KraleV, 2018 [31]	Age; Price; Mobile platform; Related to science research; Work offline (asynchronous work); Accessibility; Communication; Social skills; Math skills; Functional skills; Languages; Organizer; Entertainment; Educational; Medical care; Use media like video, audio, images.
W. T. Nakamura, L. C. Marques, L. Rivero, E. H. de Oliveira, and T. Conte, 2019 [27]	<i>Type of Technology:</i> Written Reporting; Oral Reporting; Observation/Monitoring <i>Information Source:</i> Users; The Development Team; UX Experts <i>Location:</i> Controlled environment; Field <i>Type of Assessed Application:</i> Generic; Web Application; Mobile Application; Others <i>Type of Assessed Artifact:</i> Conceptual Ideas; Design Models; Functional Prototype or Finished App. <i>Assessed Period of Experience:</i> Before Usage, During Usage; After Usage <i>Collected Data:</i> Qualitative; Quantitative; Both <i>Supports Correction of Identified Problems:</i> Availability; Available for Free / Under a License; Not Available
A. Aldiab, H. Chowdhury, A. Kootsookos, F. Alam and H. Allhibi, 2019, [25]	Page; URL; File; Folder; Legend; Book; Lecture; Syllabus; Dictionary; Lesson plan; Video; Integration; Discussion; Chat; Reports; Inquiry; Comments; Blogs; Survey; Quick mail; Task; Tests; Workshop; Safe Assignment; Group mode; Wiki; Virtual classroom; Internal mail; Calendar; Tracking; Statistics; Database; Language adjustment; Certificates

In the studied literature, besides the advantages and disadvantages, some strategies for comparison of different LMS platforms are presented. Some of these references we will discuss here. We should note that the most widely considered and investigated platforms are Moodle and Blackboard. They are at the top of almost all rankings for LMS platforms.

A comparative analysis of six LMS platforms (Moodle, Sakai, ATutor, Blackboard, SuccessFactor, SumTotal) is presented by Kasim et al. in [24].

A study of commercial LMS platforms - Moodle, Blackboard, Canvas, and D2L (Desire to Learn) is presented in [25]. The criteria used in the cited article by Aldiab et al. are based on another study presented in [26]. But only four LMS platforms - Claroline, Moodle, Blackboard, and Enterprise Knowledge PlatformTM were evaluated with a method proposed by Poulova et al [26]. The main drawback of these articles is that they do not explain the choice of the e-learning platforms.

A study devoted to the practical using and the quality of some LMS systems can be read in [27]. Nakamura et al. have defined the User eXperience (UX) as the main factor determining the success of software. The criteria proposed by the authors (Table 1), taking only the users' skills and the features of the e-learning platforms are used to evaluate only the Edmodo LMS software.

A theoretical model based on adaptive structuration theory evaluating, according to which the appropriate LMS was determined and its effect on the learning process, was proposed in [28]. They define that good IT support is one of the factors that help and facilitate the user.

A model of an LMS system in which "both teachers and learners have the same possibilities of control and action in the platform ", is presented in [29].

The use of e-learning systems for learners with special education needs also makes progress. Various scientific publications discuss education methodologies or describe only one LMS platform [30]. An exception appears to be a paper [31] in which an attempt to present a generic model for evaluating the software for the learning of the children with special educational needs is made.

What is important for quality software development is the making of an unambiguously defined software specification. The features and functions of the software are based on this specification. That is why the analytic study of the main features of the LMS platforms will allow the creation of a well-formulated specification, and in turn, to support the creation of quality software applications. For adequate communication between different Learning Management Systems (LMS), SCORM standard for a "Sharable Content Object Reference Model" was created. This standard required the unified support of content packaged a transferable ZIP file in all LMS systems. Its practical applicability and importance in the modern e-learning environments is discussed in [32]–[35].

The factors and criteria for evaluating of LMS platforms taken from some of the references discussed in this section are presented in Table 1. Based on these results, we selected the criteria for analysis of LMS platforms in this article.

Many of the analysed articles discuss the problem of qualities evaluating of the e-learning systems only from a

pedagogical view. In this kind of science articles, the quality and implementation of the LMS platform (in terms of software design and development) are irrelevant. An example is [16], in which the important factors determining the quality of LMS systems are aimed at the learners, and the LMS evaluation is focused on the effect of the learning process.

Using the existing social networks (Facebook) and mobile applications for video chat and voice calls (Skype) as tools for teaching and learning is a new trend in the modern classroom. Increased interest in social networks, as well as the influence they have on the modern way of teaching and teaching, they are presented in [37], [38].

Based on the presented analysis of the state-of-art science research presented in this section and Table 1, the following criteria for analysis of the LMS platforms were summarized:

- *Learning Skills Tools*: Creating activities and learning tools
 - o SCORM Compliant (code L1)
 - o Lectures as web pages, documents, presentations, video etc. (code L2)
 - o Examples and tasks, as web pages, documents, presentations, video etc. (code L3)
 - o Assignments and exercises as web pages, documents, quizzes (code L4)
 - o Gamification (code L5)
 - o Evaluation (code L6)
- *Communication Tools*: Allows interaction between lecturers and students
 - o Chat (code C1)
 - o Forums (code C2)
 - o Email messages (code C3)
- *Productivity Tools*: The software functionalities provided by LMS systems
 - o Uploading/downloading various documents types (code T1)
 - o Add, edit, delete data for students (code T2)
 - o Analysis of students' achievements and outcomes (code T3)
 - o Multiplatform support (code T4)
 - o Security and protection of users' data (code T5)
 - o Creating a data backup (code T6)
 - o Need for a system administrator that can manage all the user roles in the LMS (code T7)
 - o Web-based technology of software development (code T8)
 - o Need for installation (code T9)
 - o Self-Registration (code T10)

We used these evaluation criteria to analyses several learning management systems. The abbreviation codes in brackets are for the sake of space saving when presenting the results.

III. RESULTS AND DISCUSSION

This study base on an empirical approach divided into two stages. In the first stage, the criteria for analysis of e-learning software are selected. These criteria are based on the study of the scientific works, published during 2004-2019 and presented in the previous section. The second stage consists of the selection of LMS systems to be analysed. After conducting search with keywords "e-learning system",

"mobile learning" and "learning management system" in Google and Bing search engines, 36 LMS frameworks were selected. For the sake of completeness, the collected data have been presented in two tables (Table 2 and Table 3) that

comply with the criteria set out in this article. This information was collected from the websites of the LMS systems whose addresses have been presented in the first column of Table 2.

TABLE III
TECHNICAL INFORMATION OF THE LMS ANALYZED.

Learning management systems	Price/ License	Users according to the website of the LMS	Supported interface languages (sum)
Adobe Captivate Prime (https://www.adobe.com/products/captivateprime.html)	4\$ per month/1299\$ full license	1,000,000 +	10
Atutor (https://atutor.github.io/)	Open Source	N/A	62
BizLibrary (https://www.bizlibrary.com)	N/A	100,000 +	1
BlackBoard (https://www.blackboard.com)	N/A	25,000,000	25
Brightspace (https://www.d2l.com/)	N/A	15,000,000+	12
Chamilo (https://chamilo.org/en/)	Open source (GNU License)	1,200,000	3
Cornerstone OnDemand (https://www.cornerstoneondemand.com/learning)	8\$-20\$ per user	80+ companies	45
Docebo (https://www.docebo.com)	N/A	6,000,000	40
Edmodo (https://www.edmodo.com/)	Free or 2,500\$/school/year	58,000,000	16
Edsby (http://www.edsby.com/)	N/A	N/A	46
Educadium (https://www.educadium.com/)	99\$ per month	N/A	100+
eFront (https://www.efrontlearning.com/)	750\$ per month	N/A	40
Instructure (https://www.instructure.com/)	N/A	20,000,000	34
iSpringLearn (https://www.ispringsolutions.com)	970\$ per year	160,000	1
Latitude Learning (https://www.ispringsolutions.com)	1\$ per month	4,200,000	4
LearnLinq (https://www.learnlinq.com)	200€ per month	750,000	14
LearnUpon (https://www.learnupon.com)	499€ per month	4,000,000	11
Lessonly (https://www.lessonly.com/)	N/A	N/A	12
Litmos (https://www.litmos.com/)	6\$ per month	4,000,000	28
Mindflash (https://www.mindflash.com/)	N/A	N/A	24
Moodle (https://moodle.com/)	Free / Premium	142,106,528	100+
NEO LMS (https://www.neolms.com)	Free / 0.05 per user	1,125,219	40+
Open edX (https://open.edx.org/)	Open Source (GNU License)	14,000,000	5
Saba Software (www.saba.com)	N/A	33,000,000	40+
Sakai (https://www.sakailms.org/)	Open Source (GNU License)	N/A	18
SAP SuccessFactors (www.successfactors.com)	N/A	48,750,000	96
Schoology (http://www.schoology.com/)	Free/Enterprise License	10,000,000+	6
SkillSoft (http://www.skillsoft.com/)	Free/Paid	23,000,000	29
SkyPrep (http://skyprep.com/)	349\$ per month	250,000+	5+
ProProfs (https://www.proprofs.com)	Free / 59\$ per month	1,000,000	100+
SumTotal (https://www.sumtotalsystems.com/)	N/A	500+ companies	29
TalentLMS (www.talentlms.com)	Free/29\$ per month	2,600,000	13
Tortal Training LMS (https://www.tortal.com/learning-management-system-lms)	Free/Paid	493,000	1
Thinkific (www.thinkific.com)	Free/49\$ per month	11,400,000	31
WizIQ (www.wiziq.com)	20\$ per month	500,000	21
WorkWize (https://www.workwize.com)	5900\$ annually	N/A	8

We analysed the selected LMS platforms with the criteria proposed in the previous section. The part of their technical specification, taken from LMS' websites, is presented in Table 2. The "N/A" is written in the place where information was not found.

An interesting observation is that very few of the studied LMS systems have an open source, such as *Atutor*, *Chamilo*, *Sakai*, *Open edX*. But other e-learning systems provide free versions of their limited-edition software, and multiple of them have paid versions. Almost all studied LMS platforms meet the requirements described in the "Sharable Content

Object Reference Model" (SCORM) standard [39] except for Cornerstone OnDemand, Edmodo SkillSoft, Thinkific, WorkWize.

Most of the modern LMS systems provide multilingual interface support, making it easier for users to use their native language. As an example, only 28% of the studied LMS platforms supported up to 10 different interface languages, and the remaining 72% of them support more than 10 interface languages.

Only 3 of the platforms, namely, Tortal Training LMS, iSpringLearn, and BizLibrary, support only English as

interface language. This variety of languages can be defined as a good practice for software developers, which inevitably

leads to an increase in the reach of users, which is also apparent from Table 2.

TABLE IIIII
THE LMS ANALYZE.

Learning Management Systems (LMS) Platforms	Learning Skills Tools						Communication tools			Productivity Tools									
	L1	L2	L3	L4	L5	L6	C1	C2	C3	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Adobe Captivate Prime	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Atutor	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
BizLibrary	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
BlackBoard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Brightspace	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
Chamilo	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cornerstone OnDemand	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
Docebo	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Edmodo		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Edsby	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓			✓		✓
Educadium	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
eFront	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Instructure	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
iSpringLearn	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Latitude Learning	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
LearnLinq	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓		✓	✓		✓
LearnUpon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Lessonly	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
Litmos	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Mindflash	✓	✓	✓						✓	✓	✓	✓	✓	✓	✓		✓		✓
Moodle	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NEO LMS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Open edX	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ProProfs	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Saba Software	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Sakai	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
SAP SuccessFactors		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Schoology	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
SkillsSoft	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
SkyPrep	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
SumTotal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
TalentLMS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Thinkific		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Tortal Training LMS	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
WizIQ		✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
WorkWize	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Count of true (✓)	32	36	36	32	25	35	17	25	36	36	36	36	36	36	28	34	36	8	34
Count of false	4	0	0	4	11	1	19	11	0	0	0	0	0	0	8	2	0	28	2

The more interface languages are supported by one software, the greater the number of its users. The abbreviation codes used in the second-row have been described in the previous section. If the LMC has some of the requested features, the "✓" sign is set on the respective place.

All the features that the LMS systems have and which are the subject of this study are presented in Table 3.

The obtained results are illustrated in Figure 1. The general functionalities that most of the studied LMS platforms possess are clearly shown.

The analysis confirms that 89% of the platforms meet the SCORM standard. Solving tasks and assignments and adding solutions to the e-learning environment is possible only in 89% (*L4* criteria). Although there are varieties of social networks and instant messaging software applications, only 47% of the analysed systems have provided chat capability,

and 69% of all of them support a forum. If this does not change in the future LMS systems, it is quite possible that the impact of the social networks will increase in the field of education, and soon we will start talking about social network learning management systems.

Another problem observed in this study is a feature of creating data backup. As an example, the users of cloud-based LMS are hardly able to automate the process of creating data backup.

In modern systems, the ubiquitous use of web-based technologies for developing the new platforms appropriated for every computing device is observed. Some studied systems have proposed the support for self-register and creating new user profiles (*T10* criteria). Hence, more people can have an equal access to education.

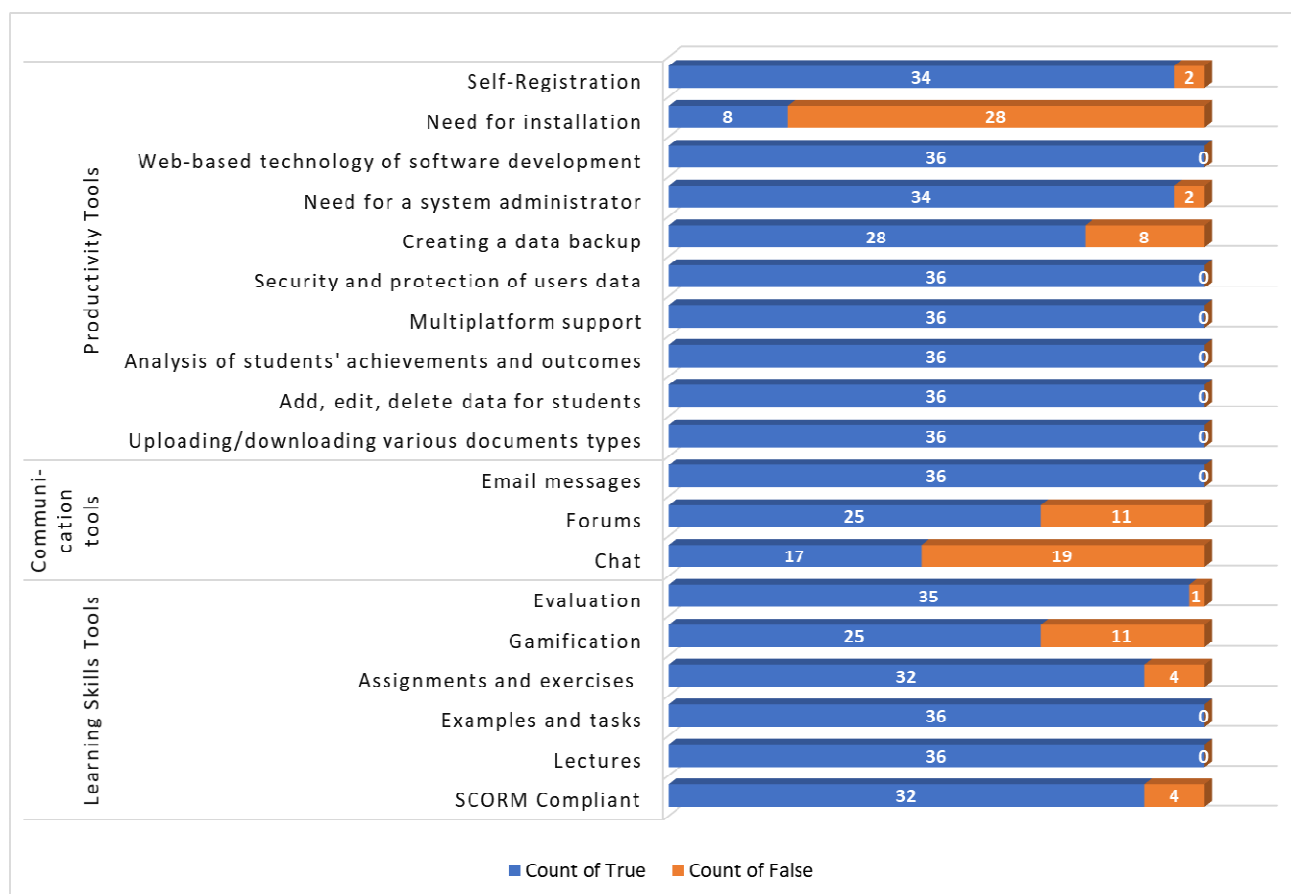


Fig. 1 Graphical presentation of the obtained results after the analysis of the investigation of 36 LMS platforms

Based on our survey, the main trends in modern LMS platforms can be summarised as follows:

- Providing cross-platform support
- Asynchronous work
- Multilingual interface support
- Support of the user self-registration - the user can create an account without a pre-request to an administrator.
- Improving gamification
- Improving the communication between users, such as sharing text and multimedia information, and

bringing the modern LMS systems closer to the concept of social networks.

- Using cloud technology to create LMS platforms, reducing the need for specialized computer equipment such as web servers, web addresses, and network administrators to support them.
- Capability to easily create and manage lectures, exercises and tasks by teachers and facilitated solution to these tasks by pupils/students, using interactive management models.

IV. CONCLUSIONS

This article presents an empirical study of the qualities of 36 modern LMS platforms. The study was carried out in two stages. In the first step, the state-of-art literature was discussed, and the criteria for analysis of e-learning systems were selected. In the second step, we focused on the choice of LMS platforms for investigation. We used specific keywords in Google and Bing search engines for the selection of such software.

As a result of this study, we can conclude that most LMS systems have similar features. All of them support the use of multimedia elements, creating and editing the lectures, exercises and course assignments. Only 86% of the studied systems meet the SCORM standard, and no evaluating systems of the learners' knowledge are possible in 5% of them. An interesting result that only 46% of all the systems provide chat support and only 68% of them have forum support. This result confirms the trend that the LMS platforms without any communication support for users are more suitable for a blending learning tool. The lack of communication support leads to using web forums and social networks out of the LMS, which contradicts to the concept of a unified learning environment system.

Despite the significant advances in software development and the relatively long period of use of e-learning systems, they still do not meet all the criteria for an LMS, although their authors defined them as e-learning systems. This can further confuse the end-users, e.g., teachers, pupils/students and parents. As a future trend of LMS systems, we can point to the enhancement of real-time communication between individual users, the use of these systems as cloud services and the inclusion of added and virtual reality to their capabilities.

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