

METHODOLOGICAL APPROACHES TO THE SELECTION OF LEARNING MANAGEMENT SYSTEMS FOR USE IN THE EDUCATIONAL PROCESS

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***Abstract:** The article proposes a methodology for comparative analysis of learning management systems (LMS) for their selection as a means of studying and as a goal of studying in educational institutions. The methodology is based on the criteria: open source / freeware; architecture; ease of installation/administration; set of services; possibility of localization; interface. The most well-known LMS with Ukrainian localization are analyzed and selected for use in the educational process. The results of the students' study are analyzed and LMS that are the most suitable for application in their future professional activity are clarified.*

Keywords: educational process, learning management systems, software selection.

INTRODUCTION

The global process of transition to the information society requires significant changes in many areas of activity. Thus, it is considered necessary to ensure the development of education on the basis of new progressive concepts, introduction of the latest pedagogical technologies and scientific and methodological achievements in the educational process, and the creation of a new system of information provision of education. The development of the educational system should lead to:

- expanding access to all levels of education for a large number of people;

- the implementation of the system of continuous education, which opens the opportunity for permanent deepening of general education and professional training, achieving of integrity and continuity in education and upbringing;
- individualization of training.

In today's Ukraine, the use of e-learning systems is spreading, and when developing training courses, the problem of selecting appropriate systems among existing systems with Ukrainian localization becomes a topical issue. We have proposed criteria for selecting LMS for use in the educational process, and we focus not only on the educational aspect of products, but on IT aspects, in connection with the training of specialists in education and computer science, which will mainly create the structure of the courses and will serve them. At the same time, content and educational aspects of courses concern the competence of specialists of the relevant subject areas. The aim of the work is to determine the appropriate criteria for selecting LMS, to evaluate the systems commonly used in Ukraine in accordance with these criteria and to define the LMS that enables future specialists to acquire competences for the creation and administration of electronic courses.

Due to the development of the Internet and modern methods of communication and data exchange, the popularity of e-learning is growing. It becomes possible to create and apply more qualitatively: electronic workbooks, encyclopedias, tests, glossaries, questionnaires, virtual laboratories, etc. Elements of e-learning (computer-based learning) are widely used in distance education.

At present, there is a large number of Learning Management Systems (LMS) that include tools both for organizing and monitoring the use of training courses, and for administering the educational process as a whole.

One can distinguish several basic types of e-learning support software: authoring software for creating learning resources, Learning Management System (LMS), Computer-managed instruction (CMI), Content Management System (CMS) and Learning Content Management Systems (LCMS). Interpretation of terms relating to e-learning in some countries is given in Smyrnova-Trybulska, E. et al., 2017.

To a greater or lesser extent, the basic functions of such systems are defined as 3R (Registration, routing and Reporting) (Smyrnova-Trybulska, E., 2007).

These systems have a similar structure that contains the following common elements:

The subsystem of registration provides registration of new users (students, pupils), and also registration of a session of work of an already registered user. In addition, this subsystem can provide import / export of user accounts from other / to other sources.

The subsystem of routing provides the start of learning and the learning process itself, directing the student through the sections and stages of the system, providing

him with the necessary elements of the interface. In addition, this subsystem can provide the choice (change) of the path of learning based on certain logical conditions (test results, a list of previously studied topics, etc.)

Subsystem of reporting provides students with the opportunity to get information about the results of their studies, assessments. The teachers additionally receive a complete picture of the work of students (pupils) and a statistical analysis of the data on the learning process in general.

1. GENERAL STRUCTURE OF LMS

Taking into account a large number of e-learning systems, one should examine some very important elements that need to be considered when choosing such a system.

The structure of the e-learning system should provide the creation and conducting of courses that take into account the specifics and features of users. Such a system should not only offer services of sending data and materials, but also provide necessary formation of practical skills.

Providing different ways of communication between students, as well as between the student and tutor will give one an opportunity to understand the teaching material easily, through the possibility of exchanging views (in the forum, in chat, through mail). In addition, a knowledge validation system, that provides the teacher with the ability to assess students' knowledge online, is also important. Typically, such a system includes tests, tasks and control of students' activity.

One of the essential elements implemented in the systems is the element of exploration of the entire learning process. All events related to the course must be registered. Due to this, the teacher can analyze the operational data about the results obtained by the students.

An important role in choosing a system plays its cost (Horoshko, Y. et al., 2010). The cost consists of the cost of the system itself, as well as the cost of its implementation, the development of courses and support, the presence or absence of restrictions on the number of licenses for students.

The correspondence of the system to The Sharable Content Object Reference Model (SCORM) and the Aviation Industry Computer-Based Training Committee (AICC) is quite important. This ensures compatibility of courses carried out on different systems, as well as control over the student's learning achievements. The SCORM standard is based on the XML language and describes the internal representation of the courses in the system. If any two systems of distance learning support this standard, then there is an opportunity to immediately move the entire course from one system to another.

From the student's point of view, the convenience of use of the system is important. This is a significant parameter, because potential students will never use a technology that seems cumbersome or difficult to navigate. Learning technology should be intuitive. The training course should provide the opportunity to simply find the help menu, easily switch from one section to another and communicate with the instructor.

The presence of a national product localization is important. The localized version of the product is more user-friendly both for administering, courses, and for end users of educational services.

Also significant is the system updatability. New, improved versions of the system with the support of new technologies, standards and tools should be issued regularly.

2. CRITERIA FOR SELECTION OF LMS FOR USE IN EDUCATIONAL PROCESS AND THEIR APPLICATION FOR ANALYSIS OF WIDESPREAD LMS

At present, there have been developed many of such systems, provided with a large number of management and use services. This necessitates their comparative analysis in order to select distance learning systems as a means of learning and as a goal of studying in different types of educational institutions.

The comparative analysis of LMS used in the universities of Sri Lanka is given in (Thuseethan, S. et al., 2015). The comparison of different LMS mainly in terms of their productivity is given in (Kor & Tanrikulu, 2008).

We propose the following methodology for conducting such a comparative analysis based on the criteria:

- open source / freeware
- architecture;
- easement of installation / administration;
- set of services;
- possibility of localization;
- convenience of the interface.

Let's consider the main characteristics of the most used LMS, using the specified criteria.

2.1 Moodle

MOODLE (www.moodle.org) - Modular Object-Oriented Dynamic Learning Environment. The MOODLE software platform is free and open source software,

which is distributed free of charge and with open source software and complies with the SCORM standard.

Some practical recommendations for effective use of MOODLE are provided in (Drlik et al., 2017).

MOODLE is in a Learning Management Systems (LMS) class or Virtual Learning Environments (VLE). In Ukraine such systems are often referred to as Distance Learning Systems (DLS), as it is with the help of such systems, many educational institutions have organized distance learning. The notions of LMS, VLE, DLS are often used synonymously.

MOODLE is written in PHP using the SQL database (MySQL, PostgreSQL, MariaDB, Microsoft SQL Server or Oracle) and is a multi-platform, so it can be installed on a computer with appropriate software.

To install the system, depending on the software on the computer, the developers offer either sets of source files for installation on a computer with a debugged WEB server, or additional installation packages that contain a portable WEB server and allow installing MOODLE on personal computer. The installation and initial debugging process itself is not complicated, since it is accompanied by text comments and explanations of the debugging elements. After installing, the administrator needs to perform only simple actions relative to users' work, but the system can also be used with the default settings. If necessary, almost all the parameters can be changed, but for the beginner it can cause some difficulties, because there are a lot of parameters and it is difficult to orientate at once in them.

The MOODLE system is widely used in many universities in the world and has a large number of localizations, including Ukrainian.

MOODLE is a toolkit for developing both individual on-line courses and educational Web resources. The use of LMS MOODLE provides an opportunity: to place interactive educational materials on the network; to organize independent work of students, to differentiate access to educational materials; to provide control over the process of studying the material and the execution of tasks; automate the evaluation procedure; to organize the distance interaction of the participants of the educational process; student portfolio management; preserving the history of learning.

The teacher can use both thematic and calendar structuring of the course at his own discretion. In thematic structuring, the course is divided into sections by subject. In calendar structuring, each week a course study is published in a separate section. Such structuring is convenient in the distance learning organization and allows students to properly plan their educational work.

LMS settings allow at any time to change the look and structure of the distance learning course, which makes it easy to update the content of disciplines. Editing the content of the course is conducted by the course author in an arbitrary order and can be easily implemented directly in the learning process. It is very easy to add

different elements to the electronic course: lecture, task, forum, glossary, wiki, chat, etc. For each electronic course there is a convenient page for viewing the latest changes in the course. Thus, LMS MOODLE provides the teacher with a powerful toolkit for presenting educational and methodological materials of the course, conducting theoretical and practical classes, organizing educational activities, both individual and group.

Since the main form of knowledge control in distance learning is testing, LMS MOODLE has a great tool for creating tests and conducting training and control testing. A large number of question types in test tasks (multiple choice, relevance, true / false, short answers, essay, etc.) is supported in the system. MOODLE provides many features that make testing easier. The system contains advanced tools for statistical analysis of test results and, most importantly, the complexity of individual test questions for students.

Most elements of the e-course in the LMS MOODLE can be evaluated. The teacher can create and use different assessment systems within the course. All ratings are collected in a general log, which contains convenient mechanisms for summarizing and reporting. MOODLE provides an opportunity to control attendance, student activity, time of their academic work in the network, provides the efficiency and comfort of the process of independent work.

Learning LMS, and in particular MOODLE, in the process of training future educators always entails certain difficulties. This is due to the fact that for such systems quite often there are no recommendations for a single look, no translation into the Ukrainian language, no matching services. There is no commonly used terminology. Each particular system is installed, adjusted and refined in different ways. However, this has its advantages, because one site SUN is not similar to another.

2.2 eFront

eFront (<https://www.efrontlearning.com/>) is an open system that combines the functions of the Learning Management System (LMS) and the Learning Content Management System (LCMS).

The eFront system is written in PHP using the SQL database (MySQL) and is a multi-platform, so it can be installed on a computer with the appropriate software. The system is developed using a paradigm of object-oriented programming, and its architecture is based on a three-tier design approach, which separates the representation of the system from its logic and data.

With regard to the installation of the system, eFront in this sense is very different, and, for the better, from the considered above MOODLE system, because it requires much less technical skills. The system is easy to install on the Windows operating system; Ubuntu or other GNU / Linux operating systems, if required software has been previously installed. Moreover, all processes are documented and described in detail. That is, any user, even technically weakly trained, is

unlikely to have problems with installation. Once installed, system settings can be changed, and their change is more understandable, in our opinion, in comparison with MOODLE. At present, in addition to installing the system on the servers of the educational institution, the registration and placement of the training portal on the eFront resource is provided. However, such a service is not free; therefore it is not always suitable for non-commercial educational institutions.

The eFront system has a large number of localizations, including Ukrainian.

In the eFront system there is a large number of parameters for adapting the look and structure of the training portal, which facilitates the integration of the system into the WEB-resource of the educational institution.

The use of the LMS eFront provides the opportunity to solve the problems of organizing the educational process in educational institutions, as well as training, certification and selection of employees in organizations of different sizes.

Due to the flexible organization of the structure of the system, there are wide opportunities for determining the roles for users and, accordingly, delimiting their access to the elements of the system. The system has the ability to create dynamic groups, that is, users can be divided into segments that are logical for an educational institution and will display its hierarchy.

The system provides a very easy way to fill the course with study materials that may include: hypertext pages, attached files, links to external resources, glossaries, wiki, forums, etc. Also, the course author may use materials from previously placed courses or, if necessary, edit the content of the course, even directly in the learning process.

For evaluation of theoretical knowledge and practical skills of students, the possibility of conducting individual or group surveys, assignment of tasks, the results of which students can transmit in various formats (typing text, sending files, links) is provided. Also, the system provides the ability to create test questions of different types. Based on the results of the tests, various reports can be generated, either by individual tests or courses, or by individual users.

A quite important element of the system can be considered the possibility of creating rules for the course. These rules will control access of users to the elements of the course, determine the order of passing all the elements of the course and the terms of completion of the course as a whole.

It can be noted that the DLS eFront is primarily intended for the academic sector. However, there is also the possibility of commercial use, as there is a corresponding set of services in the system, namely the registration of staffing, tracking career changes, etc. In general, LMS eFront is a very high-quality and functional system, which undoubtedly deserves a lot of attention.

2.3 ATutor

ATutor (<http://www.atutor.ca/>) is an open-source web-based learning management system (LMS).

The ATutor system is written in PHP using the SQL database (MySQL) and is a multi-platform, so it can function on a computer with the corresponding software. And since the system is modular, that is, it consists of separate functional units - modules, then it is open for the modernization and expansion of functionality.

Installing the system, as well as the process of updating it, is not complicated. For further work it is necessary to take several steps, in the process of that the system will check the installed software and the parameters with which it operates. All stages of installation are documented and described in detail. The ATutor system has a large number of localizations, including Ukrainian.

ATutor supports the ISM and SCORM specifications to ensure compatibility with courses for other distance education systems.

ATutor supports three types of users - the administrator, the instructor (teacher) and the student. Depending on the role of the user, he is given the appropriate set of services. After installing the system, the administrator has a fairly limited interface, despite a large number of rights granted to him. So the main tasks of the administrator are to update the system, to change localization, to correct personal accounts, to change the privileges of access, to install new themes. And, most likely, the most inconvenient one is that the administrator should create categories of courses (Kostiuchenko, A., & Shkardybarda M., 2013).

When creating training courses, the teacher can use both a built-in editor of materials and download files with the necessary training material, for example, with text of lectures, practical classes, etc. in a variety of formats. In addition to the actual teaching materials, the courses may include dictionaries of terms, lists of literature and the period of familiarization with them, invaluable surveys, students' opinions on a particular topic.

In order to provide communication between the participants of the educational process, the system has both synchronous (chats, teleconferences, whiteboards) and asynchronous (ads, forums, internal messages, e-mail, blogs, wikis, comments in file exchangers) means.

Students in the course can be tested, although with a small number of types of questions (multiple or single choice, question type true / incorrect, and open questions to which the student himself must write a response). As a result of tests, reports can be generated. Also, for the analysis of students' work, the system provides the possibility of reviewing used materials.

ATutor is a complete and free distance education system that is easy to expand and adapt and can be successfully used both for internal use at educational institution and for access to materials on the Internet.

2.4 Prometheus and Google Classroom

At present, not only fully-fledged training management systems that require installation and debugging can be used to conduct distance learning, but web resources that are already prepared for common use. Such resources allow the organization of an educational environment on their basis. Thus, there is no need for an educational institution to host and administer a remote environment using a ready-made platform. Among such portals, we would like to draw attention to the systems Prometheus and Google Classroom that are widely used in Ukraine.

Prometheus (<https://prometheus.org.ua>) is a public project for mass open online courses to provide the creation and placement of such courses on its own online platform.

Prometheus not only creates and hosts mass open online courses on its own site, but also provides a free opportunity for universities and organizations to publish and distribute courses. So a university, organization or company can become a member of the Prometheus project, get its own page on the online platform, and the right to free courses. Important in this regard is the preservation of intellectual property rights for courses by those who create them.

The system assumes the availability of educational material both in the form of texts, and in the form of video lectures. For discussions with other students and teachers, it is possible to create forums for specific courses. The consolidation and verification of the knowledge gained in the system is ensured through a variety of interactive tasks and tests. The "Prometheus" system provides not only the possibility of obtaining new knowledge for students, but also the possibility of obtaining certificates as a result of successful training.

Google Classroom (<https://classroom.google.com/>) is a free service for educational institutions and nonprofit organizations that can be used to support distance learning. In fact, Google Classroom provides the opportunity for teachers to organize a standard online learning process.

Classroom is another service from Google. This service aims to provide users with a versatile tool for working by quickly integrating other Google services: Gmail, Docs, Calendar, Drive, and more.

To work with Google Classroom, one needs to create a free G Suite for Education account for the educational institution and determine which Google services will be available to teachers and students.

The teacher can create so-called classes, which can be structurally related to a certain discipline. When creating a class, a unique code is generated so that students can use to join this class. This approach dismisses the teacher from the need to create accounts for students.

After creating a new class on the teacher's Google Drive, a corresponding folder is created in which the teacher will be able to post the teaching materials. When

students enter a class, they get the appropriate folder on their Google Drive with subfolders for each class they join. With the further creation of tasks from the teacher in the form of a Google document, the platform provides distribution of individual copies of the document for each student in the class. In addition, when creating a task, the teacher should specify the timing of its execution, which will be displayed in the student's calendars, and they will be able to see and control the process of their execution. The reports on completed tasks are updated in the teacher's panel in real time, and he can check the work and evaluate it.

With the combination of notices made by a teacher and the ability to comment on tasks, teachers and students always have the opportunity to stay in touch and keep abreast of the status of each task.

However, it's worth noting that Google Classroom does not provide the ability to create test tasks, and therefore some external services will need to be used to control the learning.

3. COMPARISON OF SELECTED LMS

After the analysis, the full-featured DLS MOODLE, e-Front and Atutor were selected to form the contents of the course "Creating and Administration of Distance Educational Resources".

More detailed comparative characteristics of the selected DLS are given in Table 1.

Table 1.

Comparison of Open Source Learning Management Systems

System element	MOODLE	eFront	ATutor
Division of courses into categories	+	+	+
Availability of change roles for users	+	–	–
Distribution of users by groups	+	+	+
Placement of text materials	+	+	+
Placement of multimedia materials	+	+	+
Conducting polls, questionnaires	+	+	–
Organization of chats and forums	+	+	+
Videoconference (teleconference)	+	–	+
Creation of collective design work	+	–	+
Feedback	+	+	+
Tests	+	+	+
Reuse test questions (single query base)	+	–	+
Tasks for performing on-line	+	–	–
Ability to download files by students	+	+	+

Rules for passing the elements of the course	–	+	–
Keeping statistics (scores, marks)	+	+	+
Availability of reports	+	+	+
Compliance with the SCORM and AICC standards	+	+	+
Ability of extensions by additional modules	+	+	+

Source: Own work

After studying the course "Creating and Administration of Distance Educational Resources" students of the Taras Shevchenko National University "Chernihiv Collegium", were asked to answer a number of questions to identify their assessment of the features and capabilities of various distance learning systems.

When conducting the survey, students were offered to evaluate the functional capabilities of distance learning systems, the convenience and intuition of the actions of the administrator, teacher and student on a five-point system (from 1 to 5). The survey was attended by 64 graduate students in educational specialty (31 students in the 2016-2017 academic year, 33 students in the 2017-2018 academic year).

In the course of studying "Creating and Administration of Distance Educational Resources", students worked with LMS in three roles such as administrators, teachers and students. As administrators, they installed and configured appropriate systems. As teachers, they created and filled out distance courses and further analyzed results of study. As students, they learned studying the courses of other students.

The results of these surveys are presented in Tables 2, 3 and 4.

Table 2

Set of services of the system (score from 1 to 5)

System element	MOODLE	eFront	ATutor
Administration of the system	4,8	4,3	3,8
Work with users	4,7	4,2	3,8
Services for creating educational materials	4,9	4,1	3,2
Reporting services	4,7	4,3	2,7
Services for student analysis	4,7	3,9	2,5

Source: Own work

Table 3**Convenience and intuition of actions performed by the administrator and teacher (score from 1 to 5)**

System element	MOODLE	eFront	ATutor
Installation and initial administration (the minimum necessary to set up the system for work)	3	4,8	3,5
Deep administration (conducting additional debugging of individual elements of the system)	2,2	4,3	3,5
Work with users (creation / registration, distribution of roles, enrollment on the course)	3,9	4,0	3,8
Filling with educational materials	4,8	4,6	3,9
Filling with reporting elements (tests, surveys, tasks)	4,0	4,3	2,8
Conducting an analysis of student activity	4,2	4,2	3,9

*Source: Own work***Table 4****Convenience and intuition of student actions (score from 1 to 5)**

System element	MOODLE	eFront	ATutor
Convenience and intuition of the interface	3,8	4,6	2,8
View educational materials	4,6	4,6	3,8
Passing tests	4,7	4,5	4,2
Analysis of own activity at the course	4,8	4,8	4,3

*Source: Own work***CONCLUSION**

As a result of learning on the course "Creating and Administration of Distance Educational Resources", students gained competences in working with selected LMS and created real distance courses that could be used by them in their further professional activities.

The results of the research (analysis of Tables 2, 3, 4) revealed the necessity of making partial changes to the work program of the course "Creating and administering distance education resources" to increase the learning time for the study of the LMS MOODLE, since in the aggregate of indicators this system was rated by the students the highest. The updated work program focuses on the study

of the characteristics of systems that have proved to be the most difficult for students and received lower marks.

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