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CRITERIA FOR SELECTING A CLOUD-BASED LEARNING MANAGEMENT SYSTEM FOR A HIGHER EDUCATION INSTITUTION

Abstract. The paper explores the essence of the criteria and indicators which can be used to select a cloud-oriented learning support system for a higher education institution. The following criteria with corresponding indicators are identified: design criterion (reliability, accessibility, multilinguality, security, adaptability, ease of use and administration, free use); technological criterion (user access rights differentiation, cloud storage of data, integration with other cloud-based services, ability to download different types of files); communication criterion (user registration, communication between registered users, creating groups, creating forums and chats); information-didactic criterion (structuredness, calendar, assessment of student achievement, file sharing, testing and surveys, group and individual modes of work; analytics for a particular course). The most downloaded LMS are shown based on the results published by LMS Market Share. The paper offers an analysis of a number of cloud-based learning management systems (Google Classroom, Moodle, Edmodo, Studyboard, Oracle, Learner Nation, iSpring, Canvas, Schoology, Blackboard, NeoLms) in terms of the above-mentioned criteria and indicators. The systems were selected based on the method of expert evaluation. The expert evaluation showed that the most convenient and high-quality cloud-based learning management system for building a cloud-oriented learning environment of a higher education institution which best meets all the criteria are NeoLMS, Canvas and Google Classroom. These LMS offer all the functionalities which are essential in the educational process. We see the development of methodological recommendations for higher education regarding the high-quality and successful implementation of such learning management systems in the educational process as prospects for further research.

Keywords: criteria; selection criteria; cloud-based LMS; learning management system; higher education institution.

1. INTRODUCTION

Problem statement. The task of deploying network-based educational process organization systems and designing cloud-based learning environments at higher education institutions (HEIs) is accomplished by creating specialized platforms called Learning Management Systems (LMS) or Learning Support Systems (LSS). They are used to develop, manage and disseminate online learning materials, providing shared access to their users. Course materials with a set sequence of their study are placed in a learning environment. LMS comprise various individual tasks, projects for working in small groups and learning elements for all students, both content- and communicative-oriented.

There are a number of learning management systems that give the possibility to learn using the Internet. Thus, the learning process can be carried out in real time by delivering online lectures and seminars. LMS are characterized by a high level of interactivity and allow people from different countries to participate in the learning process, provided that they have access to the Internet.

The use of LMS, which provide the development, management and distribution of educational materials, and Learning Content Management Systems (LCMS), designed to develop educational content, is increasing dramatically on a global scale. It is predicted that the market of network learning systems will evolve into that of Talent Management Systems (TMS-systems) with automated tools for staff recruitment, performance management, training and development. A characteristic feature of Ukraine's higher education institutions is that they mostly use LMS and LCMS as open-source systems due to lack of funds and qualified personnel. This results in a number of limitations, including difficulties in integrating applications and tools and issues with importing and exporting content created on different platforms [1].

Hence, there arises the need for a comprehensive evaluation of such platforms, involving clarification of criteria and quality indicators related to the process and results of educational activities.

Analysis of recent research and publications. Recently, researchers have been increasingly exploring the potential of LMS use in the educational process. In particular, S.H.P.W. Gamage, J.R. Ayres & M.B. Behrend studied the possibilities of using Moodle in teaching university courses. They found out that Moodle is being increasingly used as a platform for adaptive and collaborative learning [2].

Alia Abdallah Ahmed Hassan analyzed the usability and functionality of software in LMS frameworks. The author argues that due to the integration of parallel work in one database it is possible to automatically synchronize and manage accounts [3].

I Kadek Suartama, Luh Putu Putrini Mahadewi, Dewa Gede Hendra Divayana, and Muhammad Yunus have developed an independent online learning module with a structured and systematic flow called Introduce, Connect, Apply, Reflect and Extend (ICARE), based on a learning management system. In addition, the researchers carried out a test of the eligibility of the module, which included testing at various stages: analysis, design, development, implementation and evaluation [4].

Mitra Sophia explored the possibility of using LMS assessment tools among faculty teaching English Composition at a community college. The aim was to increase their use for informed decision-making on student outcomes through faculty-led workshops [5].

Mohammad Hamad Al-khresheh carried out a detailed review of the overall impact of deploying the Blackboard online platform in the EFL teaching-learning process. The researcher also concludes that teachers need training, encouragement and support to use online teaching tools [6].

M. Şahin, H. Yurdugül found that learners want more entertaining and self-monitoring

environments, especially with the elements of gamification. The researchers also note that learning environments have reporting and predictive capability on student achievement. According to the researchers, learners' needs and expectations match third-generation learning management systems, which can be developed through educational data mining and learning analytics [7].

J.R. Simon and J.G. Randall argue that teachers should consider both potential benefits and costs of LMS use, as cognitive preoccupations with LMS may exacerbate learners' stress [8].

O.D. Triswidrananta, A.N. Pramudhita, I.D. Wijaya evaluated the distance learning system implemented at their university. As a result, they found that the learning management system based on learning assessment got an average score of 85.2 (the data analysis was carried out with the help of the 4D development model), which means the distance learning system was implemented well [9].

A team of authors [10] explored the possibilities of using cloud technologies in the organization of distance learning.

Criteria and indicators for selection of various types of information and communication technologies for study and research were explored by O.S. Holovnia [11], O.A. Halchevska [12; 13], K.R. Kolos [14, 15], L.A. Luparenko [16], O.R. Oleksiuk [17], O.M. Spirin [17] and others.

In particular, O.A. Halchevska analyzed the possibilities of using international scientometric open access databases in research [13], and identified criteria and indicators for the selection of scientometric systems in pedagogical studies [12].

O.S. Holovnia proposed criteria for selecting virtualization software in teaching UNIX-like operating systems [11].

K.R. Kolos carried out a comparative analysis of distance learning computer software for the organization of postgraduate education for informatics teachers [14], and proposed a process model and criteria for selecting components of computer-oriented learning environment of a postgraduate pedagogical education institution [15].

L.A. Luparenko conducted a comparative analysis of major software of electronic open access journal systems for publishing education research [16].

The research goal is to formulate the criteria for the selection of a cloud-based learning management system and identify indicators corresponding to these criteria.

2. RESULTS OF THE RESEARCH

According to the form of their use, LMS are commonly divided into two types [18, p. 117]:

1. ***LMS as software***, designed for installation on HEI servers. To use LMS of this type, HEIs obtain the corresponding service from its provider by IaaS cloud model. Naturally, operation of such LMS requires appropriate personnel and software.

2. ***LMS as a Web-platform*** created by its provider, which is used for educational process management. To use LMS of this type, HEIs obtain the corresponding service from its provider by SaaS cloud model. In such a case, all the major functions related to ensuring proper operation and providing technical support are performed by the provider.

According to the data published by LMS Market Share, the most downloaded LMS in 2021 were those presented in Fig. 1 [19].

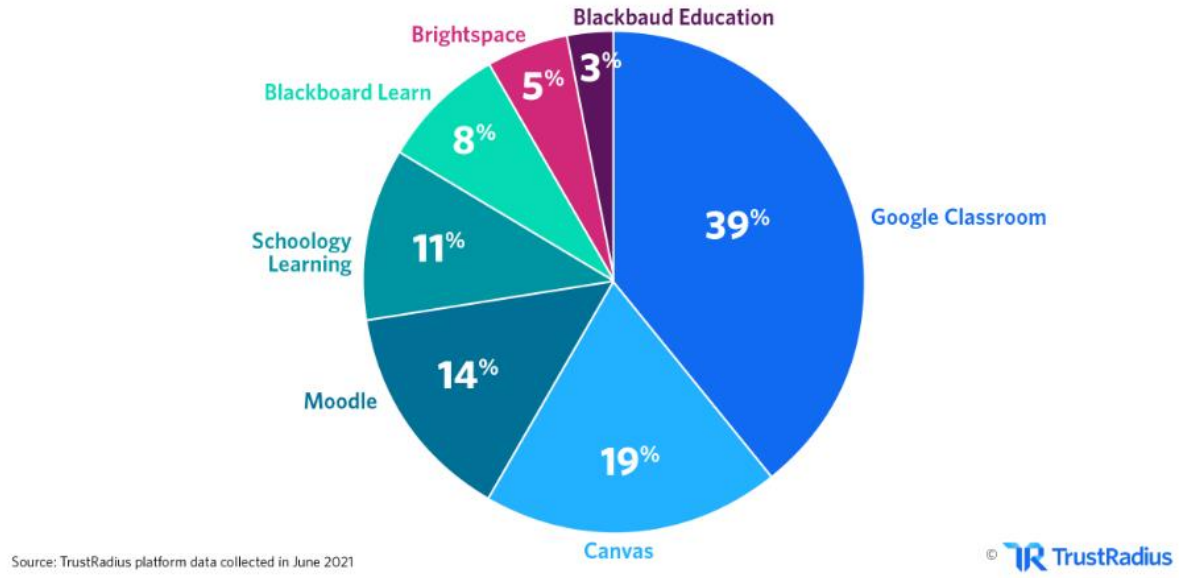

Fig. 1. The most downloaded LMS in 2021 (data provided by LMS Market Share [19]).

Let us look at some LMS offered by global providers.

Moodle [20] is a free and open-source learning management system used for e-learning across the globe, which can be customized for any educational institution. This LMS was developed in Australia.

The main features of LMS Moodle are no use fees, image deployment on the server, mobile and web interface, educational documentation, possibility to conduct webinars, online teaching and learning, personal space, online support and more.

Edmodo [21] – when working with this system, teachers and students create free accounts, and then the teacher creates his/her own group. One teacher can have several groups, and each student can be a member of several groups.

In this LMS, teachers can store course materials available to students for download, receive and evaluate students' assignments. Edmodo is a convenient platform for communication and interaction, especially for those who have experience in using social networking services like Facebook.

Features of this LMS: English interface, ease of use, no fees, no advertising.

Learner Nation [22] is a cloud-based LMS created in 2012 in the United States, which enables companies and organizations to create and deploy learning environments for any needs.

The main features of this LMS are availability of a free demo version, image deployment on the server, mobile and web interface, educational documentation, the possibility to conduct webinars, online teaching and learning, personal space, online support and more.

iSpring [23] is an easy-to-use cloud-based learning management system for use in the educational process and for evaluation of employees or students on the Internet, created in 2007 in the United States.

The main features of this LMS are a free trial, mobile deployment, web interface, educational documentation, the possibility to conduct webinars, online teaching and learning, personal space, online support, starting price of $ 1,270.00 per year, etc.

iSpring offers a wide range of functionality in one e-learning platform complete with a cloud LMS and PowerPoint. It is possible to create multimedia courses and quizzes and publish them instantly and directly on the LMS. There is a powerful system of user roles, which allows you to control access throughout the LMS for individual groups and organizations. Students

and teachers are given the opportunity to keep in touch. A detailed reporting system analyzes students' progress through the course material.

Schoology [24] is a technology for universities and schools which combines LMS and cloud technologies. The main functionalities provided by this LMS are mobile deployment, web interface, educational documentation, the possibility to conduct webinars, online teaching and learning, online support and more.

Schoology is an LMS which allows students and teachers to communicate and learn not only within a single university, but across the globe. Schoology helps the teacher to track student performance. Teachers are also provided with tools which quickly individualize a team, develop and implement strategies for maintaining and streamlining accreditation reporting procedures.

The highlight of the platform is its great potential for interaction and joint work in various modes: student-student, teacher-teacher, teacher-student, and in small groups.

On the course page, teachers can publish assignments, collect students' works and grade them, mark deadlines in the calendar, conduct discussions, testing, store course materials which can be downloaded by students.

There is a function of creating groups, in which teachers can add both students and other teachers, including those from other educational institutions. Students can create their own groups, whose functioning is monitored by the educational institution.

Blackboard [25] is one of the most popular LMS in the world, especially with HEIs. It is the only fully paid platform in our list. Its price is not specified on the site, being available only on request. This LMS provides the whole range of functionalities expected of a learning management system, with new features constantly appearing, such as: anonymous grading, delegating grading to an assistant, using audio or video as feedback, analytics, etc.

Google Classroom is a free cloud service (see Fig. 2) developed by Google for educational institutions.

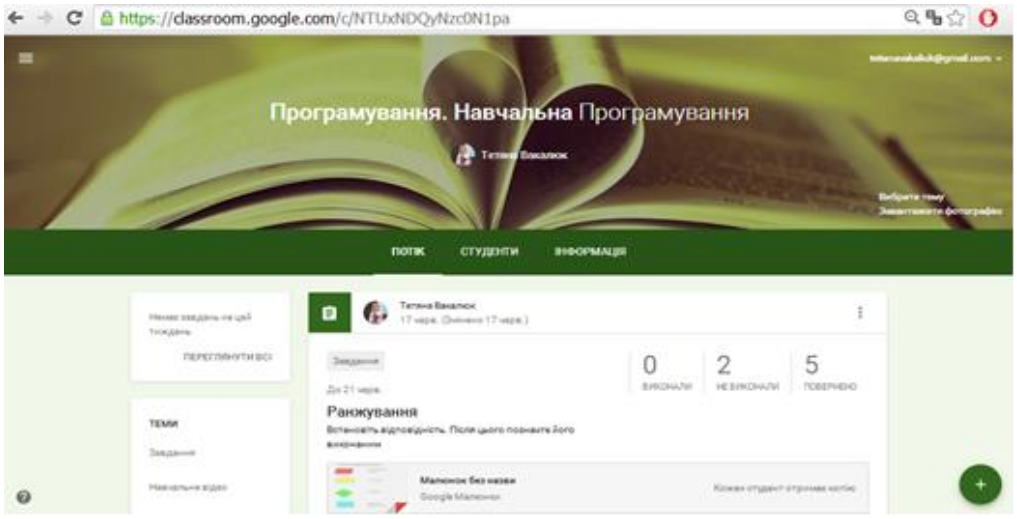

Fig. 2. Google Classroom

In Google Classroom, teachers can easily and quickly create and check students' assignments in electronic form. The assignments and students' works are automatically arranged in a structure of folders and documents on Google Drive, coherent to both teachers and students (see Fig. 3). Classwork page shows students which assignments they have to perform. Information about completed assignments is constantly updated (in real time). Also, this service provides an opportunity to add comments to a graded assignment.

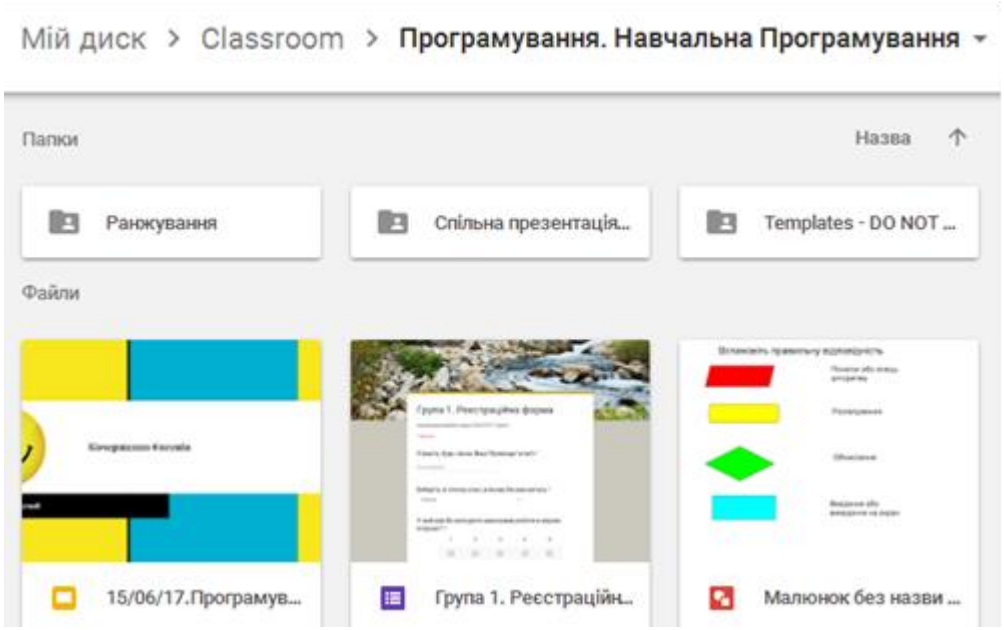

Fig. 3. Automatically generated structure of folders and documents on Google Drive.

Here are the main specific features that should be taken into account when working with Google Classroom:

- ✓ Personal settings for Google Classroom – each newly created class has a specific access code, which is used to join the class (see Fig. 4).
- ✓ Creating assignments and monitoring their completion – after a teacher has created an assignment (using Google Docs), the Google Classroom service will make and distribute its copies among all students enrolled in the class (see Fig. 5). The teacher can monitor the completion of either all tasks simultaneously or a single task as needed. Google Classroom has the option of setting deadlines.

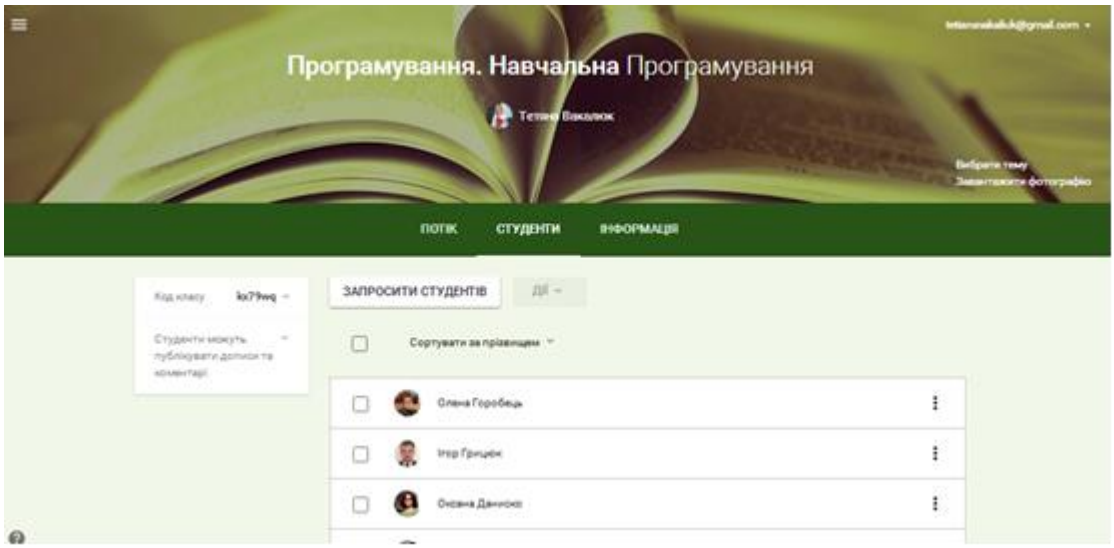

Fig. 4. Google Classroom access code and students

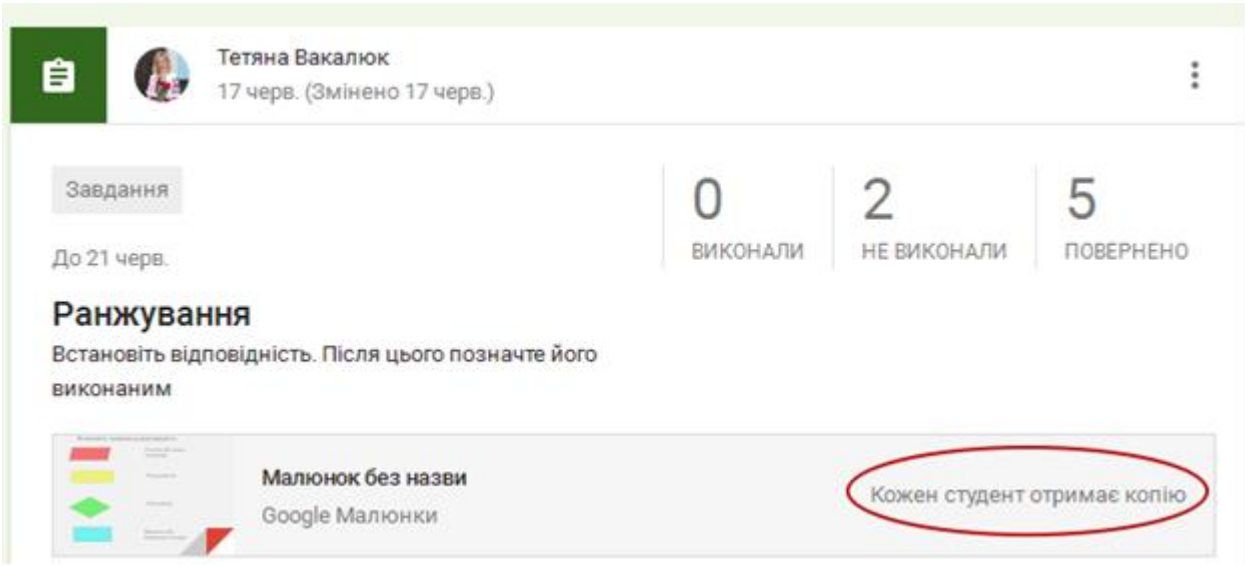

Fig. 5. Google Classroom: major functionalities

✓ Communication in Google Classroom – the service provides an opportunity to post announcements, as well as leave comments to assignments and graded works (see Fig. 6). These options help teachers and students keep in touch.

✓ Integration of Google Classroom and Google Drive – after creating a class, a folder with the class materials is automatically created on the teacher's Google Drive, after which the students also automatically get such a folder.

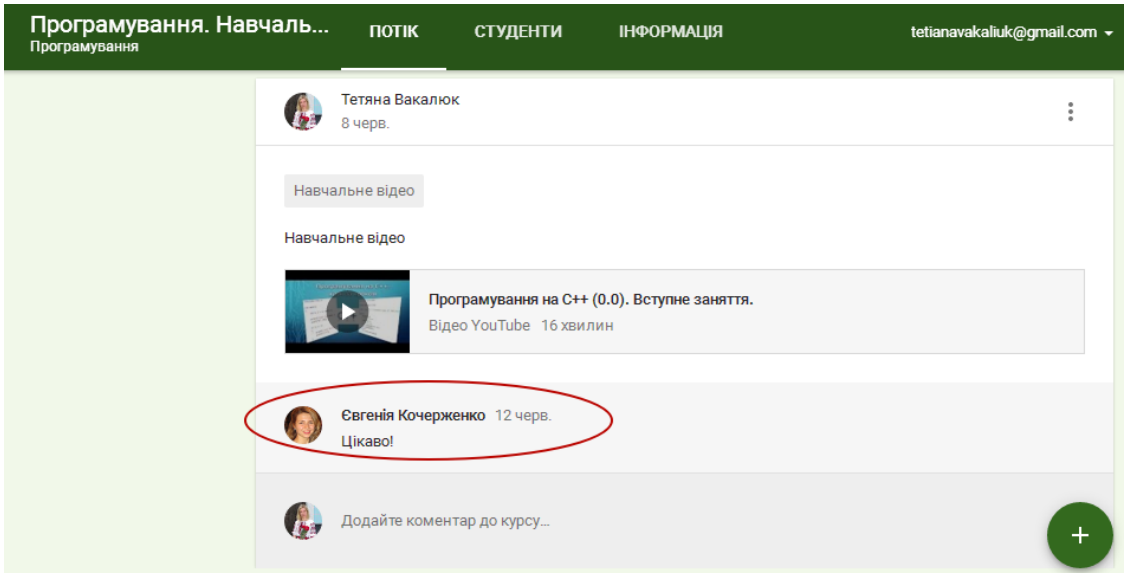

Fig. 6. Communication in Google Classroom

Google Calendar is an online calendar that can be shared with all users signed in to the domain.

Google Docs and Google Sheets enable joint work on documents and spreadsheets. This is essential for group projects carried out as part of the educational process. Google Docs has a special feature for the teacher, Revision History, which allows viewing revisions made in a document by each user.

Google Forms allow teachers to create surveys, quizzes and questionnaires. This service is ideal for assigning homework and organizing students' independent work in class. The service provides the teacher with a convenient summary of students' answers.

Google Sites is a collection of website templates, which can be used to create a personal website. This is an innovative alternative to traditional students' reports or essays. Projects created using Google Sites have a platform for comments and statistics services, which means that each student can receive feedback from the teacher and classmates.

All these services look simple, but their strength precisely consists in simplicity and integration with each other. As a matter of fact, a teacher can create a short presentation using Google Slides, work in class with Google Forms and Google Sheets, set a home assignment using Google Forms, fix its deadline in Google Calendar and arrange reminders to be emailed to the students about the scheduled assignment.

NEO LMS [26] is an award-winning LMS used globally by schools and universities. The platform is known for its ease of use, enjoyable interface and an impressive set of cutting-edge features. With NEO, it is easy to create comprehensive courses, which can be used by students anytime and anywhere. NEO is a product of CYPHER Learning, which also provides similar LMS for use by businesses.

The main features provided by this LMS are a free version, web deployment, educational documentation, online learning, personal space, online support, etc.

NEO [17] is an LMS for use by individual teachers, schools, districts and universities, which enables online learning. NEO provides a range of functionalities, such as classroom support, a powerful gradebook, training programs and courseware, collaboration and communication tools, and more. NEO has a beautiful, easy-to-use interface with an adaptive design for Android mobile applications.

Analysis of NEO LMS functionalities allows us to conclude that they embrace the major functional blocks of traditional server LMS, providing the possibility of making fine individual settings. It can be integrated with the Google Apps service. In addition, the platform has its own built-in social network and a parent account feature. The free version has a 400-student limit. This LMS can support educational process at schools and HEIs which do not have their own servers.

Taking into account the LMS functionalities, on the one hand, and specifics of educational process in HEIs, on the other, we formulated the criteria for selecting a cloud-based LMS.

First of all, it was necessary to define the concept of "criterion", which is given various interpretations by scholars. I. Dychkivska in her short terminological dictionary defines a criterion as an indicator that characterizes the property (quality) of an object, the evaluation of which is possible using one of the measurement methods or the expert method [27, p. 344]; other researchers believe that a criterion is a set of features serving the basis for the assessment of the conditions, the process and the results of activities, which meet the set goals [28, p. 105]. In the "Philosophical Dictionary" the concept of "criterion" is understood as a feature, a mark, serving as the basis of assessment, a means of verification, a measure of evaluation [29].

By ***the criteria for selecting a cloud-based learning management system*** (CBLMS) we understand those qualities, features and properties of a CBLMS which are essential for its effective use in the educational process and overall successful operation.

The most relevant cloud-based learning management systems were identified using the method of expert evaluation.

Experts were engaged at several stages. At the first stage, they helped to identify the most high-quality and effective cloud-based learning management systems. The experts engaged were deans of faculties, heads of departments and academics of Ukrainian HEIs (the total of 20 people).

The method of expert evaluation used to identify these LMS consists in numbering LMS in ascending or descending order based on a certain feature and ranking them accordingly.

In total, the experts were offered for ranking twenty different cloud platforms and cloud-based learning management systems which can be used in the educational process of HEIs.

The experts were offered a scoring system, in which for N CBLMS the highest in quality CBLMS gets N, and the lowest - 1. The results of the surveys are summarized in a table, where the column header indicates the CBLMS numbers, and the row header – the experts' numbers. In order to eliminate potential psychological clues that could influence the experts' ranking, the CBLMS were arranged alphabetically in ascending order.

The main factor in assessing the value of an indicator is its aggregate rank S. The aggregate ranks of the indicators were calculated by the formula

$$S_j = \sum_{i=1}^{m} R_{i,j}, \quad (1)$$

where S_j is the aggregate rank of the *j*-th indicator;

j=1, 2, 3…n; n – number of the indicators;

m – number of the experts;

$R_{i,j}$ – rank of the j-th indicator, given by the i-th expert.

However, such aggregate ranks will be objective on condition that there is a certain level of agreement among the experts. The degree of such agreement is determined by Kendall's coefficient of concordance *W* [30]. Taking into account that

$$d_j = S_j - 0{,}5 \cdot m \cdot (n+1), \quad (2)$$

$$S(d^2) = \sum_{j=1}^{n} d_j^2, \quad (3)$$

and the maximum value $S(d^2)$ is achieved if all the experts perform the ranking equally and $S_{\max}(d^2) = \frac{1}{12} \cdot m^2 (n^3 - n)$, Kendall's coefficient of concordance is calculated by the formula:

$$W = \frac{S(d^2)}{S_{\max}(d^2)} = \frac{12 \cdot S(d^2)}{m^2 (n^3 - n)} \quad (4)$$

Having performed calculations using formulas (1)-(4), based on the experimental data, we obtained a certain value of W. If the value obtained differs significantly from zero, it can be argued that there exists objective agreement among the experts (if W=0, it is believed that the expert rankings are not related; if W=1, the rankings completely coincide), so the aggregate ranks are quite objective.

Having performed calculations using formulas (1)-(4), based on the experimental data from the expert survey (see Table 1), we obtained W=0.76.

Table 1

CBLMS ranking

CBLMS number / Expert number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1	10	13	9	4	18	3	2	20	6	14	15	7	19	12	5	16	11	17	8
2	9	18	17	1	6	12	7	8	10	4	16	15	3	11	20	5	14	19	13	2

3	8	16	18	4	7	10	1	9	14	5	20	13	2	15	19	6	12	17	11	3
4	1	18	17	8	5	11	3	2	10	7	15	16	6	12	20	4	13	19	14	9
5	9	10	13	1	6	17	7	8	15	4	14	20	3	16	12	5	19	11	18	2
6	4	18	10	9	1	15	6	5	17	3	11	12	7	16	20	2	13	19	14	8
7	5	20	19	8	2	11	3	4	12	7	16	15	6	13	18	1	10	17	14	9
8	7	10	15	1	4	19	5	6	10	8	14	13	9	11	17	3	18	20	12	2
9	3	19	16	8	2	10	1	4	11	6	17	14	7	12	20	5	13	15	18	9
10	2	19	14	9	5	18	1	3	12	7	13	16	6	10	15	4	11	20	17	9
11	9	20	15	3	6	17	7	8	10	4	13	12	1	18	16	5	11	19	14	2
12	5	10	11	6	2	14	8	9	18	4	13	19	3	17	12	1	20	16	15	7
13	1	19	16	4	9	15	3	2	17	7	11	10	6	14	20	8	13	18	12	5
14	9	20	19	1	6	12	8	7	14	4	10	13	3	15	18	5	16	17	11	2
15	5	18	17	4	8	11	7	6	15	1	16	10	2	12	19	9	14	20	13	3
16	3	15	17	9	5	19	1	2	10	7	13	12	6	20	14	4	18	16	11	8
17	3	10	13	2	6	18	5	4	20	8	14	15	9	19	12	7	16	11	17	1
18	8	18	17	1	6	14	7	9	15	4	10	11	3	16	20	5	12	19	13	2
19	4	19	11	9	1	14	6	5	12	3	18	17	7	13	10	2	16	20	15	8
20	3	17	14	1	6	20	5	4	10	9	18	13	8	11	15	7	12	16	19	2
S	99	**324**	**302**	98	97	**295**	94	107	**272**	108	**286**	**281**	104	**290**	**329**	93	**287**	**340**	**288**	101
d	-111	114	92	-112	-113	85	-116	-103	62	-102	76	71	-106	80	119	-117	77	130	78	-109

The value obtained differs significantly from zero, so it can be argued that there is objective agreement between the experts and the aggregate ranks are quite objective.

According to the results of the survey, we selected: Google Classroom; Moodle; Edmodo; Studyboard; Oracle; Learner Nation; iSpring; Canvas; Schoology; Blackboard; NeoLms.

At the second stage, another group of experts was asked to perform selection from among the most relevant CBLMS. For this purpose, the expression of each of the identified criteria in each of the above-mentioned CBLMS was analyzed by means of a corresponding questionnaire. During scientific conferences, workshops, seminars, personal meetings, round tables, e-mail communication, etc., a significant number of deans of faculties, heads of departments and academics of Ukraine's HEIs were acquainted with the results of the CBLMS use (a total of more than 50 people, at a rough estimate). However, the data concerning the expression of each of the criteria in each of the selected CBLMS were taken from 20 respondents.

To determine the degree of expression of each criterion, the respondents were asked to assess its indicators. The indicators were assessed by the following scale: 0 – the indicator is absent, 1 – the indicator is partially present (more absent than present), 2 – the indicator is more present than absent, 3 – the indicator is fully present. The indicator was considered positive if the value of the corresponding coefficient – the arithmetic mean of its parameters – was not less than 1.5.

Next, a criterion was considered insufficiently expressed if less than 50% of its indicators were positive; critically expressed if 50-55% of its indicators were positive; sufficiently expressed if 56-75% were positive, and highly expressed if 76-100% of its indicators were positive.

The conducted analysis of the CBLMS allowed us to identify the following criteria and their corresponding indicators for the selection of cloud-based learning management systems:

1) *design criterion*: reliability, accessibility, multilinguality, security, adaptability, ease of use and administration, free use;
2) *technological criterion*: user access rights differentiation, cloud storage of data, integration with other cloud-based services, ability to download different types of files;
3) *communication criterion:* user registration, communication between registered users, creating groups, creating forums and chats;
4) *information-didactic criterion:* structuredness, calendar, assessment of student achievement, file sharing, testing and surveys, group and individual modes of work; analytics for a particular course.

The ***design criterion*** refers to convenience, reliability, safety of use and administration of a CBLMS.

The "reliability" indicator refers to the steady and flawless functioning of a CBLMS.

The "accessibility" indicator implies that a CBLMS, provided that the Internet is available, can be accessed by anyone, at any time and in any place (both by teachers and students).

The "multilinguality" indicator refers to a CBLMS supporting different languages.

The "security" indicator requires authorization and authentication of a CBLMS users before accessing all its resources, as well as prevention of data interception by third parties.

The "adaptability" indicator characterizes a CBLMS in terms of its adaptation for use with different operating systems (Windows, Android, iOS, etc.).

The "ease of use and administration" indicator implies that a CBLMS should be easy to use for both students and teachers, i.e. convenient and intelligible in terms of use and organization of access, can be easily mastered by different groups of participants of the educational process.

The "free use" indicator refers to the availability of a free tariff plan, even if not fully functional. This indicator was included in the design criterion because a full-featured version differs from a free version in the framework of a CBLMS design.

The basic data on the indicators of the design criterion for each of the selected CBLMS are accumulated in Table 2.

Table 2

CBLMS design criterion and its indicators

CBLMS indicators	Reliability	Accessibility	Multilinguality	Security	Adaptability	Ease of use and administration	Free use	Criterion expression
Google Classroom	2.45	2.60	2.80	2.60	2.80	2.55	2.80	100%
Moodle	1.45	2.15	2.45	2.35	2.15	1.30	2.05	71%
Edmodo	2.25	2.20	0.20	2.20	2.00	1.25	2.25	71%
Study-board	2.20	2.35	1.30	2.25	2.50	1.40	1.20	57%
Oracle	2.20	2.35	1.30	2.25	2.50	1.40	1.20	57%
Learner Nation	2.20	2.35	1.30	2.25	2.50	1.40	1.20	57%
iSpring	2.35	2.45	1.25	2.50	2.65	1.35	0.00	57%
Canvas	2.20	2.15	2.25	2.25	3.35	1.50	2.25	86%
Schoology	2.15	2.35	1.45	2.20	2.35	1.30	1.15	57%
Black-board	2.15	1.75	1.45	2.20	2.35	1.30	0.70	43%
NeoLms	2.60	2.60	2.70	2.55	2.25	2.50	2.75	100%

The ***technological criterion*** characterizes a CBLMS from the technological point of view and refers to the presence of the following indicators:

- "user access rights differentiation", which requires differentiation of the right to access the system for different categories of users: students, teachers, administrators, parents;
- "cloud storage of data", referring to whether a CBLMS has restrictions on the cloud file storage;
- "integration with other cloud-based services", which refers to a CBLMS integration with well-known cloud services, such as Google Apps for education, Office 365, etc .;
- "ability to download different types of files", which indicates whether users can download different types of files (video, audio, presentations, documents, etc.).

The basic data on the indicators of the technological criterion for each of the selected CBLMS are accumulated in Table 3.

Table 3

CBLMS technological criterion and its indicators

CBLMS indicators	User access rights differentiation	Cloud storage of data	Integration with other cloud-based services	Ability to download different types of files	Criterion expression
Google Classroom	2.30	1.55	1.80	2.45	100%
Moodle	2.05	1.35	1.05	1.30	25%
Edmodo	1.90	1.35	1.70	1.30	50%
Studyboard	2.15	1.30	0.35	2.25	50%
Oracle	2.10	1.15	2.25	2.45	75%
Learner Nation	2.40	1.30	1.35	1.25	25%
iSpring	2.30	1.45	1.30	2.40	50%
Canvas	2.40	1.55	1.80	2.30	100%
Schoology	2.25	1.15	2.45	2.10	75%
Blackboard	2.25	1.15	2.10	2.45	75%
NeoLms	2.30	2.40	2.45	2.60	100%

The ***communication criterion*** refers to the means and methods of communication in an CBLMS. It is manifested in the following indicators:

- "user registration", which refers to new students' being able to register on their own, without outside support;
- "communication between registered users", which refers to the availability of support of all possible interactions between the participants of HEI educational activities;
- "creating groups", which refers to the possibility of creating groups for more convenient communication and notification of users;
- "creating forums and chats", which refers to the possibility of creating forums and/or chats.

The basic data on the indicators of the communication criterion for each of the selected CBLMS are accumulated in Table 4.

Table 4

CBLMS communication criterion and its indicators

CBLMS indicators	User registration	Communication between registered users	Creating groups	Creating forums and chats	Criterion expression
Google Classroom	1.55	1.60	1.55	1.55	100%
Moodle	1.60	1.60	1.40	0.50	50%

Edmoodo	2.10	2.25	2.25	1.30	75%
Studyboard	2.35	2.25	2.20	1.30	75%
Oracle	2.55	2.50	1.30	2.30	75%
Learner Nation	2.50	2.55	1.30	1.30	50%
iSpring	2.55	2.55	1.30	1.30	50%
Canvas	2.55	2.55	2.45	2.50	100%
Schoology	2.55	2.55	2.50	1.30	75%
Blackboard	2.55	2.50	2.50	1.30	75%
NeoLms	2.60	2.60	2.45	2.35	100%

The ***information-didactic criterion*** characterizes the informational and didactic component of a CBLMS and comprises the following indicators:

"structuredness", which refers to the possibility of systematizing course materials in conformity to the curricula and syllabi of academic courses;

"calendar", which refers to the availability of a calendar in a CBLMS, or at least the possibility of integrating a calendar from other cloud services;

"assessment of student achievement", which refers to the availability of online grading of student work and keeping a register of students enrolled in the course;

"file sharing", which indicates whether a CBLMS offers the possibility of downloading laboratory and practical works in the form of files;

"testing and surveys", which refers to the possibility of conducting surveys, tests, questionnaires, etc.;

"group and individual modes of work", which refers to the possibility of interaction with the teacher and other students individually, in microgroups and larger groups, support and organization of students' joint work in a group, possibility of joint access to different resources;

"analytics for a particular course", which shows whether a CBLMS can monitor student attendance, keep records, provide analytical information on the percentage of completed assignments, etc.

The basic data on the indicators of the information-didactic criterion for each of the selected CBLMS are accumulated in Table 5.

Table 5

CBLMS information-didactic criterion and its indicators

CBLMS indicators	Structuredness	Calendar	Assessment of student achievement	File sharing	Testing and surveys	Group and individual modes of work	Analytics for a particular course	Criterion expression
Google Classroom	2.00	2.35	1.55	1.55	2.30	1.55	1.30	86%
Moodle	1.30	2.30	1.40	1.35	2.35	1.55	1.40	43%
Edmoodo	1.40	2.30	1.55	2.35	2.35	1.55	1.30	71%
Studyboard	1.40	1.35	1.55	2.35	2.35	1.30	2.30	57%
Oracle	1.40	2.30	2.35	1.35	2.35	1.30	2.30	57%
Learner Nation	2.35	2.30	2.35	1.35	2.35	1.30	2.30	71%
iSpring	1.40	2.30	2.35	1.35	2.35	2.30	2.30	71%
Canvas	2.00	2.30	2.35	2.00	2.30	2.00	2.00	100%
Schoology	2.55	2.4	2.35	2.45	2.00	1.35	1.30	71%
Blackboard	2.00	2.45	2.4	2.35	2.55	1.30	1.35	71%
NeoLms	2.55	2.45	2.4	2.45	2.55	2.55	2.35	100%

The summarized results are presented in Table 6.

Table 6

Summarized results of selecting CBLMS, based on all the criteria

CBLMS criteria	Design	Technological	Communication	Information-didactic
Google Classroom	100%	100%	100%	86%
Moodle	71%	25%	50%	43%
Edmoodo	71%	50%	75%	71%
Studyboard	57%	50%	75%	57%
Oracle	57%	75%	75%	57%
Learner Nation	57%	25%	50%	71%
iSpring	57%	50%	50%	71%
Canvas	86%	100%	100%	100%
Schoology	57%	75%	75%	71%
Blackboard	43%	75%	75%	71%
NeoLms	100%	100%	100%	100%

3. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH.

As our research has shown, in terms of convenience and quality, the best cloud-based learning management systems for building a cloud-based learning environment of a higher education institution, based on the analysis of all the criteria, are NeoLMS, Canvas and Google Classroom.

These LMS offer all the functionalities which are essential in the educational process: a single integrated system for monitoring student progress and keeping electronic registers; online correspondence, testing and grading; possibility of distance learning; possibility of creating a library of books, manuals, textbooks and media files; file storage; conducting video conferences; provision of remote notification of the educational process participants and communication between them without violating their personal space.

We see the development of methodological recommendations for higher education regarding the high-quality and successful implementation of such learning management systems in the educational process as prospects for further research.

REFERENCES (TRANSLATED AND TRANSLITERATED)

[1] O. M. Spirin. "Information and digital technologies of the virtual university of postgraduate education", in *IV All-Ukrainian electronic scientific and practical conference "Open education and distance learning: from theory to practice"*, November 20, 2019 Kyiv, Ukraine. [Online]. Available: https://lib.iitta.gov.ua/718722/. Accessed on: Apr 19, 2022. (in Ukrainian)

[2] S.H.P.W. Gamage, J. R. Ayres, & M. B. Behrend. «A systematic review on trends in using Moodle for teaching and learning», *International Journal of STEM Education*, Vol. 9, Article number 9, 2022. doi: 10.1186/s40594-021-00323-x. (in English)

[3] Alia, Abdallah Ahmed Hassan. "The Analysis of a Learning Management System from a Design and Development Perspective", *International Journal of Information and Education Technology*. vol. 12, no. 4, 2022. pp. 280 – 289. doi: 10.18178/ijiet.2022.12.4.1616. (in English)

[4] I. Kadek Suartama, Luh Putu Putrini Mahadewi, Dewa Gede Hendra Divayana, and Muhammad Yunus. "ICARE Approach for Designing Online Learning Module Based on LMS," *International Journal of Information and Education Technology*, vol. 12, no 4, pp. 305-312, 2022. doi: 10.18178/ijiet.2022.12.4.1619. (in English)

[5] Sophia Mitra. "Role of LMS Assessment Tools", *Journal of Higher Education Theory and Practice*. vol. 22, no. 2, 2022. pp. 19 – 35. doi: 10.33423/jhetp.v22i2.5034. (in English)

[6] Mohammad Hamad Al-khresheh. "Revisiting the Effectiveness of Blackboard Learning Management System in Teaching English in the Era of COVID-19", *World Journal of English Language*, vol. 12(1):1.

2021. doi: 10.5430/wjel.v12n1p1. (in English)
[7] M., Şahin, H. Yurdugül. “Learners’ Needs in Online Learning Environments and Third Generation Learning Management Systems (LMS 3.0)”, *Technology, Knowledge and Learning*, vol. 27, pp.33–48, 2022. doi: 10.1007/s10758-020-09479-x. (in English)
[8] J.R. Simon, J.G. Randall. “Predictors and consequences of typical and “addictive” LMS use”. *Education and Information Technologies*, 2022. doi: 10.1007/s10639-022-11028-1. (in English)
[9] O. D. Triswidrananta, A. N. Pramudhita, & I.D.Wijaya. “Learning Management System Based on Assessment for Learning to Improve Computational Thinking”. *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 16 (04), 2022. pp. 150–158. doi: 10.3991/ijim.v16i04.28979. (in English)
[10] T. A.Vakaliuk, O. M. Spirin, N. M. Lobanchykova, L. A. Martseva, I. V. Novitska, and V. V. Kontsedailo. “Features of distance learning of cloud technologies for the organization educational process in quarantine”, *Journal of Physics: Conference Series*, vol. 1840, 012051, in *XII International Conference on Mathematics, Science and Technology Education (ICon-MaSTEd 2020)* 15-17 October 2020, Kryvyi Rih, Ukraine. doi: 10.1088/1742-6596/1840/1/012051. (in English)
[11] O.S.Holovnia. "Criteria for selection of virtualization software in teaching UNIX-like operating systems". *Information technologies in education. v*ol. 24. 2015. pp. 119-133. (in Ukrainian)
[12] O. A. Halchevska. Criteria and indicators for the selection of scientometric systems in scientific and pedagogical research. [Online]. Available: http://lib.iitta.gov.ua/9202/1/galchevska_.pdf. Accessed on: Apr 19, 2022. (in Ukrainian)
[13] O. A. Halchevska. “Use of international open access scientometric databases in scientific research”. *Information technologies in education. v*ol. 23. 2015. pp.115-126. (in Ukrainian)
[14] K.R.Kovalska. "Selection of computer software for distance learning for the organization of postgraduate education of teachers of informatics", *Information Technologies and Learning Tools. v*ol. 5 (13). 2009. [Online]. Available: http://journal.iitta.gov.ua/index.php/itlt/article/view/187/173. Accessed on: Apr 19, 2022. (in Ukrainian)
[15] K. R. Kolos. "Process Model and Selection Criteria for Components of a Computer-Based Learning Environment of an Institution of Postgraduate Pedagogical Education". *Information technologies in education.* vol. 17. 2013. pp. 109-117. (in Ukrainian)
[16] L. A. Luparenko. "The use of open access electronic journal systems for the production of scientific and educational publications: a comparative analysis of software", *Information Technologies and Learning Tools.* vol. 5 (25). 2011. [Online]. Available: http://journal.iitta.gov.ua/index.php/itlt/article/view/573/449. Accessed on: Apr 19, 2022. (in Ukrainian)
[17] O. M. Spirin, O. R. Oleksiuk. "Analysis of software platforms for creating institutional repositories", *Information Technologies and Learning Tools*, vol. 34, no. 2. 2013, pp. 101-115. [Online]. Available: https://journal.iitta.gov.ua/index.php/itlt/article/view/821/632. Accessed on: Apr 19, 2022. (in Ukrainian)
[18] N. Kopniuak at al. *Modeling and integration of cloud-based learning environment services: monograph*. K., TsP "Komprint", 2015. (in Ukrainian)
[19] 49 LMS Statistics and Trends for a Post-COVID World. [Online]. Available: https://www.trustradius.com/vendor-blog/lms-statistics-trends. Accessed on: Apr 19, 2022. (in English)
[20] Moodle. [Online]. Available: www.moodle.com. Accessed on: Apr 19, 2022. (in English)
[21] Edmodo. [Online]. Available: https://www.edmodo.com/ Accessed on: Apr 19, 2022. (in English)
[22] Learnernation. [Online]. Available: http://www.learnernation.com/. Accessed on: Apr 19, 2022. (in English)
[23] iSpring. [Online]. Available: http://www.ispringsolutions.com/. Accessed on: Apr 19, 2022. (in English)
[24] Schoology. [Online]. Available: www.schoology.com. Accessed on: Apr 19, 2022. (in English)
[25] Blackboard. [Online]. Available: http://www.blackboard.com/index.html Accessed on: Apr 19, 2022. (in English)
[26] Neo lms. [Online]. Available: https://www.neolms.com/. Accessed on: Apr 19, 2022. (in English)
[27] I. M. Dychkavska. *Innovative pedagogical technologies:* textbook. K., Akademvydav, 2004. (in Ukrainian)
[28] V. V. Kovalchuk, L. M. Moiseiev. *Fundamentals of scientific research: textbook.* K., Profesional, 2005. (in Ukrainian)
[29] Philosophical Dictionary. [Online]. Available: http://www.insai.ru/slovar/kriterii-0. Accessed on: Apr 19, 2022. (in Russian)
[30] S. D. Beshelev, F. H. Hyrvich. *Mathematical and statistical methods of expert assessments.* M., Statistica, 1980. (in Russian)

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КРИТЕРІЇ ДОБОРУ ХМАРО ОРІЄНТОВАНОЇ СИСТЕМИ УПРАВЛІННЯ НАВЧАННЯМ ДЛЯ ЗАКЛАДУ ВИЩОЇ ОСВІТИ

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Анотація. У статті розкривається сутність критеріїв та показників добору хмаро орієнтованої системи підтримки навчання для закладу вищої освіти.. Виокремлено критерії та відповідні показники добору хмаро орієнтованих систем управління навчанням: проєктувальний (надійність; доступність; багатомовність; безпечність; адаптивність; зручність у використанні та адмініструванні; безкоштовність); технологічний (забезпечення доступу з розмежуванням прав доступу, хмарне сховище даних, інтеграція з іншими хмаро орієнтованими сервісами, можливість завантажувати різні види файлів); комунікаційний (реєстрація користувачів, комунікація між зареєстрованими користувачами, створення груп, створення форумів, чатів); інформаційно-дидактичний (структурованість, календар, оцінювання навчальних досягнень студентів, обмін файлами, тестування та опитування, організація групових та індивідуальних форм роботи; аналітика з певного курсу). Наведено найбільш скачувані LMS, що представлені за результатами, опублікованими LMS Market Share. Наведено порівняльну характеристику певних хмаро орієнтованих систем підтримки навчання (Google Classroom, Moodle, Edmodo, Studyboard, Oracle, Learner Nation, iSpring, Canvas, Schoology, Blackboard, NeoLms) за всіма критеріями та показниками. Здійснено добір таких систем методом експертного оцінювання. Експертне оцінювання показало, що найбільш зручним та якісним інструментарієм для побудови ХОНС закладу вищої освіти за проявом усіх критеріїв є ХОСУН NeoLMS, Canvas та Google Classroom. Адже у даних LMS наявні всі необхідні функціональні можливості, які є важливими в навчально-виховному процесі. Перспективами подальших досліджень вбачаємо розробку методичних рекомендацій закладам вищої освіти щодо якісного та успішного впровадження таких систем управління навчанням в освітній процес.

Ключові слова: критерії; критерії добору; хмаро орієнтована LMS; система управління навчанням; заклад вищої освіти.