

Modern Digital Challenges and Technologies in the Educational Environment of Higher Education Institutions

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Abstract

The purpose of the article is to review and analyse the state of digital education in Ukraine, the existing platforms in the market of e-learning systems, among which the Moodle platform is preferable. Recommendations for improving the formation and development of digital education are provided, as well as proposals for performing tasks within the Moodle system itself. Also in this article were studied aspects of learning management systems application on based on this system and to develop the recommendations on improving students' self-study process at educational establishments. In conclusion the authors make recommendations on the organization of students' self-study based on LMS MOODLE as well as on the participants' personal data protection and ensuring cyber security within the system.

Keywords ¹

e-education, higher education, a learning management system, digital skills and competencies.

1. Introduction

Digital education is education that operates through information and communication technologies. The main resource of digital education is information. Digitalization of education transforms the traditional education system into an electronic educational environment of new quality, while increasing the number of electronic educational platforms and digital educational services; there is a repeated use of them, which does not depend on the location. Thanks to the sites, the information educational space expands and becomes scalable, interactions between higher education institutions, employers, and investors are established; educational programs are constantly updated, digital skills and educational innovations are developed. Digital transformation in education is understood as e-education based on digital relations in the information environment (for example, Zoom), which is associated with the unique identification of participants in the learning process who interact through information and communication and digital technologies and electronic documents [1].

“Social influence, perceived enjoyment, self-efficacy, perceived usefulness, and perceived ease of use” are the strongest and most important predictors in the intention of and students towards E-learning systems” [2].

Also augmented reality can expand the learning horizons, some of the theories focus on understanding learning processes to provide a more effective experience for students considering their personal needs and abilities [3]. A detailed overview of e-Learning is provided in such publication [4].

This includes the formation of digital competencies and skills, the introduction of digital document management, digital services in the education system, the introduction of digital competence standards, new curricula, the creation of modern and high-quality interactive educational electronic content,

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the development of digital infrastructure in education based on broadband Internet access by higher educational establishments with appropriate protection of personal data and users' rights in the educational environment.

In 2016, the European Union submitted an updated framework Digital Competence (DigComp 2.0), consisting of 5 main blocks of competencies (information and data literacy, communication and collaboration, digital content creation, safety, problem solving) and a total of 21 competencies [5].

Current socioeconomic conditions, Ukraine's integration into the European educational space, dynamic changes in the labor market, and Ukraine's accession to the Bologna process put forward new requirements for the education of students in higher educational establishments. In this regard, Ukraine's higher education is in the active phase of reform now. As a result of the implementation of these reforms, the practice of higher educational establishments should be brought into line with world and European standards. In this context, the issue of updating curricula, work programs, and educational subjects' content is important. A list of innovations also relates to the redistribution of teachers' and students' educational workload. This leads to the reduction of classroom hours and, also, to the increase of hourly load on the students' self-study (hereinafter referred to as the «SSS»).

Theoretical and methodological aspects of using LMS Moodle for distance teaching and learning have been studied by domestic and foreign scientists, namely N.M. Boliubash, [13], W.S. Wu [14], I.V. Herasymenko [15], M. Dougiamas [16; 17], I.S. Zaiarna [18; 19], K.R. Kolos [20], J.R. Cole [21], Ch.-H. Lin [22], W.H. Rice [23], K.V. Rudnytska [24], Ye. M. Smyrnova-Trybulska [25], Yu.V. Tryus [26], H.A. Shylina [27].

The analysis of the latest research allows us to specify the main advantages of organizing students' self-study by means of LMS MOODLE: centralisation (all online components of a class are accessed and archived on institutional secure servers); authentication (access to an online class is protected by password and is restricted to an institution's staff and students only, making it a secure, private and controlled environment); tracking and collating (LMS usually have features that enable tracking of assignments and statistical analysis of participation, along with the ability to synchronise marks and grades with an institution's administration systems); secure archiving (institutions are usually required to hold student related data for several years, and usually have measures in place to manage this effectively on their own systems) [1]. One of the most significant objectives for organizing students' self-study at university by means of LMS MOODLE is determining key approaches, principles and teaching methods. We believe that the organization of students' self-study by means of LMS MOODLE should be carried out from the perspective of constructivist approach, which is considered by the leading scientists as a key in the process of e-teaching and learning [28, p. 87]. The main idea of the constructivist approach is to create opportunities for students to "design" their own knowledge, skills and competence in the course of their learning activities, rather than acquiring them.

2. Problem Statement

Today, e-learning is a form of learning with the use of digital and information and communication technologies. Digital infrastructure and the Internet provide an opportunity to realize numerous benefits of e-learning including remoteness, mass character, high level of interactivity, access to e-libraries, the formation of a single educational space.

The e-learning system is managed by using specialized platforms of the distance learning system, called VLE (virtual learning environment), or LMS (learning management systems).

The purpose of the article is to review and analyse the state of digital education in Ukraine, the existing platforms in the market of e-learning systems, among which the Moodle platform is preferable. Recommendations for improving the formation and development of digital education are provided, as well as proposals for performing tasks within the Moodle system itself.

Self-study process as a system should provide optimal conditions for the student's educational and cognitive activity. Self-study process is a kind of cognitive activity that is managed and controlled by the teacher and aimed at acquiring and consolidating knowledge and skills; formation of independent personality [6]. Self-study process is very valuable, because it helps to generate exceptional features and properties of qualified professionals, cognitive activity and independence, ability to self-education and self-development. At the same time, it is not possible to achieve the goals of self-study process in

higher educational establishments and acquire the necessary competencies in the modern conditions of society, without the active using of learning management system, for example, Moodle. In the structure of the global market of electronic educational services by 2030 higher education will occupy 25% (Figure 1).

■ Post-secondary ■ K-12 ■ Lifelong learning ■ Pre-K ■ Corporate

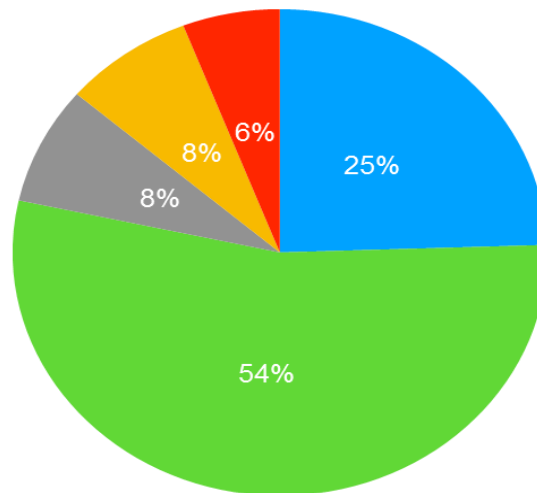


Figure 1: The structure of the world market of educational services by 2030

Source: <https://research.edmarket.ru/>.

Unfortunately, there is no analytical information on the real state of digitalization of all parts of the education system in Ukraine. Distance education is displacing the face-to-face one, and the digitalization of educational services causes competition within the global educational space. Every year the demand for distance learning grows. Many people are becoming more conscious by preferring self-improvement and development. The competition in the labour market, imperfection of university education, the desire to gain more knowledge and be competitive, global trends – all these factors contribute to the development of the market of educational services, which can be divided by sectors into distance learning; online courses; programmes and courses for self-study (books and manuals). The structure of requests for e-learning include language training - 43 %, school curriculum and preparation for exams – 24 %, professional training courses – 21 %, etc. - 12 % (Figure 2).

■ Percentage

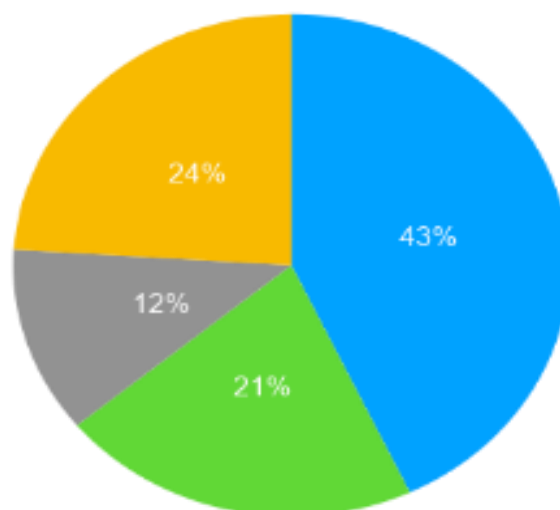


Figure 2: The structure of the e-learning demand areas

Source: <https://pro-consulting.ua/pressroom/rynok-onlajn-obrazovaniya-v-ukraine-analiticheskij-obzor/>.

The rapid development of the market of educational services and a significant increase in demand for e-education began decades ago in the world. The share of e-education in the total market is about 3-4% and it is estimated at 165 billion USD, and every year it increases by 25-30%. The world driver in this market is the USA.

In Ukraine, this market is still in its infancy. One of the first forms of such education was online courses on foreign languages. Platforms such as Prometheus, EdEra, Coursmos, etc. were the first to provide e-learning services.

Incentives for online education market development in Ukraine are the following:

- 1) outdated educational base, ie education in many higher education institutions is based on textbooks that were published decades ago, electronic textbooks are few, so many students in search of relevant knowledge seek e-courses;
- 2) the military conflict in the Eastern Ukraine, so higher education institutions in the eastern regions have begun to introduce distance learning and e-courses for students who are in the uncontrolled territories of Ukraine;
- 3) recognition by some universities of the distance format as a separate form of education, ie educational programmes and working programmes of academic disciplines for distance learning, etc. have been developed. The main advantages of e-education are its accessibility and flexible schedule; it means that the user can take courses at any time convenient for him/her.

The market of educational services is growing rapidly and its active development is facilitated by attracting investment. In 2019, the total amount of investment in Edtech (development of technological solutions for education) reached 18.66 billion dollars, which is 14.2% more than in 2018. The largest share falls on the United States (42.9%) and China (21.4%). Investors prefer to invest in learning tools based on artificial intelligence, this category in the structure of investment has 19.7%, while e-learning - 1.7%, and mobile learning - 15.9% [7].

Digital education in Ukraine has a number of problems. In particular:

1) low and uneven level of digitalization of education, in particular, Internet coverage. During quarantine, access to the Internet and the availability of digital devices at home became critical. According to research, in September 2019, 65% of the population had access to the Internet at home; 22% of Internet users have this access provided only by smartphone.

2) there is a lack of quality Ukrainian-language educational content. A national electronic education platform is needed. Today there has been equipment, servers, software purchased for it. But the platform can function only when it is filled with electronic educational materials, and they have not been purchased and placed on this platform.

3) Under the conditions of quarantine, the inequality in access to qualitative education has deepened even more due to limited access to the Internet and e-resources. According to the PISA international survey, in Ukraine the gap between students from large cities and students from villages is two years of study. And chances of children from families with higher socio-economic status to get better performance are in two to three times higher.

4) Teachers were quarantined due to unpreparedness for distance learning and it became clear that distance learning cannot completely replace direct communication with the teacher and in the team. After all, the joint presence and communication open up opportunities to better feel the condition of the listener, directly respond to his needs, motivate him to learn, apply educational technologies that require active cooperation between participants in the learning process [8].

There are many classifications of educational platforms. They can be divided into the following: platforms for the introduction of distance learning in schools and institutions of higher education; systems for the implementation of individual elements of distance learning; platforms for corporate training; platforms for business trainings [9].

The digital agenda (p. 20) states that the sphere of "digital" skills and competencies in Ukraine is developing in a piecemeal fashion, chaotically and is separated from academic (so-called formal) education. Outdated teaching methods, lack of educational standards, trained teachers, as well as the unavailability of digital technologies for the educational process have led to extremely low levels of digital literacy in all existing segments of the state education system (preschool, primary, secondary,

higher). The most massive and extensive formal education system does not meet the needs of the labour market, is unable to form quality labour resources, does not work for the autonomous well-being of citizens, significantly reduces their employment opportunities, capitalization [10].

In Ukraine, due to the introduction of quarantine the Ministry of Education and Science has prepared a list of platforms and programmes for distance learning that are expected to help educational process participants to learn online [11].

In particular, these are digital learning management systems, such as: Blackboard - an application for interactive learning, creating initial groups and knowledge exchange,

CenturyTech is a platform with distance learning tools,

ClassDojo is a communication platform for school that teachers, students and parents use for distance learning in school, Edmodo is tools and resources for classroom management and distance learning,

Edraak - creation and publication of interactive educational content,

Google Classroom - a free web service created by Google for educational institutions to facilitate the creation, distribution and classification of tasks without paper,

Moodle - a learning platform designed to combine teachers, administrators and students into one reliable, secure and integrated system to create a personalized learning environment, Schoology - a virtual learning environment for schools and universities that allows users to create, manage and share learning content, Seesaw is a platform for creating digital learning portfolios and learning resources.

Studies by Manukian L., Khalturina N., Bilous I, Chupalova A. for a comprehensive assessment show that one of the best platform for the introduction of distance learning in the educational environment is LMS Moodle [9, 12].

Moodle (Modular Object-Oriented Dynamic Learning Environment) is a modular object-oriented dynamic learning environment, sometimes also referred to as a Learning Management System (LMS), Course Management System (CMS), Virtual Learning Environment (VLE) or a learning platform that provides teachers, students, and administrators with a highly sophisticated set of tools for computer-based learning, including distance learning.

At the same time, students' self-study, based on Moodle system, determines the specific objectives that should be solved by higher educational establishments. These objectives include: determine disciplines, self-work in which will be based on learning managed systems; development of distance learning courses and their correct methodological support; adaptation of the Moodle systems' technological component to the needs of the educational process; providing proper cybersecurity of systems' members, protection of their personal data, protection of intellectual property rights, etc.

Thereby, students' self-study, based on active using of Moodle system actualizes in the face of modern science issues regarding research of educational, technical and legal self-study peculiarities using information and communication technologies.

Theoretical and practical aspects of the students' self-study based on Moodle system have been considered by many researchers, in particular, N. Boliubash, W.S. Wu, I. Herasymenko, M. Dougiamas, K. Kolos, J.R. Cole and others [13-17].

An attempt is made in this paper to show a number of educational, technological and legal issues related to systematic contents' updating of professional competences that students should acquire during their self-study, approximation of the personal data processing principles (rules) to the norms and standards of the European Union, the emergence of new threats to human cybersecurity and development of new teaching methods for different disciplines.

This paper intends to describe educational, technological and legal aspects of learning management systems application on the example of LMS MOODLE and to develop the recommendations on improving students' self-study process at higher educational establishments.

The specific objectives of the present study are: 1) to define the notion of «learning managed system»; 2) to describe the benefits of using learning managed systems for the organization of students' self-study; highlight the theoretical, organizational and methodological principles of using LMS MOODLE as a «leader in the world market for distance education services»; 3) to outline the characteristics of using administrative, training and communication LMS Moodles' tools (services) for organization the students' self-studying based on LMS Moodle; to describe the methodological aspects of using LMS Moodle; 4) to analyze the technical and technological features of the LMS Moodle system in relation to the content of professional competences that students should acquire during their self-

work; 5) to determine the technological advantages of LMS Moodle in comparison with other learning managed systems; 6) to reveal legal risks of unauthorized arrangement (processing) of personal data of LMS Moodle members, threats to their cybersecurity, and describe a methods of preventing these offenses; 7) to highlight the aims, main directions and requirements to the local regulation of the using LMS Moodle in higher educational establishments for the organization students' self-study.

In this research a complex of scientific methods has been applied, namely dialectical method, analysis and synthesis, formal-logical, sociological, comparative-legal, pedagogical experiment, questioning, computer simulation, method of expert evaluation, statistical method, classification and generalization.

3. The Results and Discussion

Specifications of LMS MOODLE

Moodle LMS is a modular, object-oriented, dynamic learning system that is based on free GNU GPL-based web application software. It provides the opportunity to create e-learning sites.

An important characteristic of Moodle LMS is its website [18], which is a source of information about the system and supports the interface in more than 80 languages, including Ukrainian.

Moodle LMS is used by more than 60% of the world's higher education institutions. Moodle LMS allows you to create a personalized learning space on the Internet, filled with lectures and laboratory works, hands-on exercises, etc in accordance with educational curricula.

Moodle LMS is an educational platform for K-12 schools, higher education and organizational training, in particular, such platforms as Moodle LMS, Moodle App, MoodleWorkplace, MoodleCloud, MoodleNet, MoodleEducation.

There are three ways to download the Moodle platform: install it on your own server (for free), run it on a Moodle server (MoodleCloud), or configure it with a certified partner Moodle. Moodle Partners is the network of certified experts Moodle. For example, these are well-known companies: Titus Learning Hong Cong, eThink Education UK, e-learning Japan, etc.

The e-learning Moodle platform is constantly being modified and complemented by new solutions and tools. This package is developed weekly with new patches produced by a stable development process. It contains a number of patches since release 3.8.1. The platform software is created in PHP using free databases (MySQL, PostgreSQL).

The Moodle platform can be installed on any operating system (Windows, Unix, Linux, Mac OS X), and also uses Apache, which is cross-platform software.

Currently, to install the latest version of this software platform, you can provide: PHP 7.1, MariaDB 5.5.31, MySQL 5.6, Postgres 9.4, MS SQL 2012 or Oracle 11.2. The Moodle interface language defines system settings that affect the display of block names, system messages, links, language of help files, etc. The programming languages used to support Moodle LMS are as follows: PHP, JavaScript, HTML, CSS, XML, XML Schema, Perl, Python, SQL (Table 1).

The Moodle platform has the following features: a) functionality – levels set of functions (forums, chats, analysis of the students activity), management of courses and training groups, etc; b) reliability – simplicity of administration and training management, simplicity of updating content based on existing templates, protection of users from external actions; c) stability – high level of system stability according to different modes of operation and user activity; d) modularity – the presence in the training courses of blocks set of material, integration, support of the international standard Sharable Content Object Reference Model - the basics of exchange of e-courses, which provides the transfer of resources to other systems, etc.

The Moodle Learning Management System makes it possible to fully implement eLearning because it has a mechanism for authorizing participants in the learning process; supports planning tools for the educational process; allows you to integrate different types of educational content (text, pictures, audio, video, etc); contains tools for group and individual work of the trainees, as well as testing the available knowledge, skills; allows to adapt the system to the needs of higher education institution depending on the model of organization of the educational process; allows control and monitoring, evaluation of listeners.

The Moodle educational process management system enables higher education institutions to: implement a modular (hierarchical) organization of the educational process; to introduce scientific and methodological support of departments and faculties, to integrate into the European scientific and educational space; create the digital environment for distance learning; to provide the control and monitoring of the educational process, to distribute educational digital services, to increase the students contingent, to provide the educational process with quality educational materials in electronic form, by means of automated control; provide the personal learning trajectory for each user.

Table 1
Language Breakdown

Language	Code Lines	Comment Lines	Comment Ratio	Blank Lines	Total Lines	Total Percentage
PHP	2,767,828	1,440,720	34.2%	559,403	4,767,951	69.1%
JavaScript	943,531	493,147	34.3%	210,574	1,647,252	23.9%
HTML	190,36	1,237	0.6%	23,741	215,338	3.1%
CSS	113,578	9,845	8.0%	20,961	144,384	2.1%
XML	62,018	836	1.3%	626	63,48	0.9%
XML Schema	40,408	8,752	17.8%	4,652	53,812	0.8%
Perl	1,068	154	12.6%	114	1,336	0.0%
XSL Transformation	1,06	70	6.2%	198	1,328	0.0%
Python	688	116	14.4%	42	846	0.0%
Modelica	196	0	0.0%	0	196	0.0%
SQL	184	66	26.4%	52	302	0.0%
Totals	4,120,919	1,954,943		820,363	6,896,225	

The Moodle Learning Management System enables the tutor, in particular, to create teaching materials, course, work programs, lectures, presentations, audio and video files, any images and texts, etc., modules for recording and controlling students' learning activities with the ability to set the required deadlines for students to complete tasks and module tests; instantly and flexibly adjust the teaching materials of the discipline; to provide testing and control of students' knowledge, etc. In Moodle LMS, the tutor can apply the thematic and calendar structure of the course. The course section is the section of the training course in the form of the «structure» or «calendar» that has the name and covers the resources and elements of the course.

With thematic structuring, the course is divided into sections by topic. In the calendar, each study week of the course is a separate section. The course content is edited by the course author. It is convenient to add different elements to the e-course: Lecture, Tasks, Forum, Glossary, etc. For each course there is the page to view the latest course changes. Therefore, the Moodle system provides the instructor with tools to provide course materials, conduct theoretical and practical classes, organize both individual and group student learning activities. Assessments are carried out on different scales according to the work programs of the educational disciplines created by the tutor.

It is possible to evaluate Wiki articles, glossary, forum responses by other course participants. All marks can be viewed using the course marks log, which has many settings for displaying and grouping marks.

With module-based architecture, Moodle functionality can be expanded by partner developers. you can host the variety of webinars, video conferences. One of Moodle's modules quickly connects BigBlueButton's video conferencing system to your activity list, allowing you to use your camera, get desktop images, and use it as own presentation. In addition, you can share files with other conference participants, monitor conference attendees for their presence, by asking specific questions with feedback. Moodle enables you to connect the following types of modules: course elements; Admin reports types of tasks; blocks; course formats; course reports; plugins; filters; evaluation reports; portfolio; types of questions in tests; test import / export formats; test reports; file repositories; types of resources, etc.

Due to the fact that the main form of knowledge control in distance learning is Moodle based testing, there are several types of questions in the test tasks (multiple choice, yes / no, short answers, etc.). Moodle provides the user with many characteristics that make it easy to process test results. The system supports statistical analysis of test results.

The Moodle LMS covers the number of interoperability modules of the educational process participants, such as: questionnaire, survey, glossary, practical (laboratory) lessons, seminar, workbook, chat, forum, test, Wiki, tasks and it is very useful toolkit.

4. Aspects of LMS MOODLE Application for Organizing Students' Self-Study

A Learning Management System (LMS), sometimes also referred to as a Virtual Learning Environment (VLE), is a centralised, closed system that is secured behind authentication and can only be accessed by an institution's staff and students.

In our research we consider LMS MOODLE for organizing students' self-study. Technical possibilities of this system, its accessibility, architecture and principles make Moodle (Modular Object Oriented Distance Learning Environment) extremely popular and in demand in more than 175 countries. As mentioned by V.V. Vyshnivskiy [6], conducted comparative study of nine platforms for the organization of e-learning (Moodle, ILIAS, Dokeos, A Tutor, LON-CAPA, Sakai, OpenUSS, Spaghettilearning, dotLRN) on 34 parameters, made it possible to distinguish LMS MOODLE as the undisputed leader in the world market for distance education services.

According to constructivist approach knowledge (as mentioned above in the introduction) is not transmitted from a teacher to a student, but is an individual interpretation of the information obtained. Students are seen as active participants in the contextual learning process. The role of the teacher also changes from a translator of professional knowledge to a consultant, who directs, stimulates and supports students in the process of solving educational problems [29, p. 76]. Thus, the constructivist approach defines the overall strategy of organizing students' self-study at university. However, its implementation requires the study of other subordinate conceptual provisions, such as principles and teaching methods.

Following the latest research on e-teaching and learning, we have come up to the conclusion that the organization of students' self-study should be implemented under the didactic learning principles (proximity, conscientiousness, active participation, visibility) and the psychological learning principles (motivation, individual psychological peculiarities of the student's personality, adaptive processes). These learning principles are designed to take into account the conditions of a new learning environment, which is implemented through the interface of digital tools for information processing through human-machine communication.

Effective teaching methods that meet the abovementioned approaches and learning principles are case study and project method. The case method is based on solving specific problem situations. Its key principle involves students' independent cognitive activity in an artificially created professional environment that enables them to combine the theoretical background and practical skills required for creative activity in the professional field [30, p. 154]. In turn, we consider the project method as a way of organizing students' independent activity, which should lead to their own creative and non-standard presentation. The project method ensures the integrity of the educational process, enabling students' development.

5. Legal Support for the Application of LMS MOODLE for Organizing Students' Self-study at Universities

Conducted research on educational and technological aspects of LMS MOODLE application for the organization of students' self-study allows us to identify a number of related legal issues. We divide them into the following groups:

- 1) insuring of personal data protection and proper authentication of LMS MOODLE's participants;
- 2) protection of intellectual property rights and insuring of LMS MOODLE cyber security; 3) local regulation for the organization of students' self-study based on LMS MOODLE.

Legal solution of the abovementioned issues is related to such factors as the type of discipline; specialty and the content of professional competence which students are supposed to acquire during their self-study, student's legal status, etc.

Considering the legal essence of the abovementioned factors, one of the key issues which require its resolution in the process of electronic self-study is insuring of LMS MOODLE participants' personal data protection.

Part 3 of Article 6 of the Law of Ukraine "On Personal Data Protection" stipulates that the composition and the content of personal data shall be relevant, adequate and not excessive for the intended purpose of their processing [31]. The implementation of the said provision through the prism of the problems raised in this research involves certain obligations relating to insuring of students' personal data protection to be imposed on the teacher and the administrator of LMS MOODLE. These obligations, *inter alia*, involve the following:

- 1) to ensure the processing of a minimum sufficient set of personal data about students required for the organization of self-study by means of LMS MOODLE;

- 2) to guarantee the confidentiality of information about each student's results and the content of their works, unless otherwise explicitly determined by their consent to the processing of personal data; 3) to approve the procedure for processing of LMS MOODLE participants' personal data (usually by the Academic Boards of higher educational establishments); 4) to create a secure password for LMS MOODLE participants to make it impossible to identify them in any other ways. In those cases when at least one of the students is a citizen of the European Union, the additional requirements set out in the EU General Data Protection Regulation (GDPR) are applied to the way their personal data are processed in LMS MOODLE.

In those cases when at least one of the students is a citizen of the European Union, the additional requirements set out in the EU General Data Protection Regulation (GDPR) are applied to the way their personal data are processed in LMS MOODLE [22]. One of the requirements is the necessity to guarantee the degree of protection of his or her personal data not less than that which exists in the EU Member State in which the student resided. One of the ways to resolve the issue in question is the implementation of the provision on an EU citizen's personal data stipulated in GDPR in the procedure mentioned above [33, p. 342].

Another important aspect related to LMS MOODLE participants' personal data protection involves the issue of cyber security. To resolve this problem cyber threats for LMS MOODLE's participants and components should be identified, the system of legal and technological means for addressing threats to cyber security should be developed.

Unlike other spheres of public life, the legislation of Ukraine, similarly to the legislation of the EU, does not provide for a special procedure for legal provision of cybersecurity in the field of distance learning in general and organizing students' self-study in particular. Thus, the main focus in ensuring the cyber security of LMS MOODLE and its users, when applied for the purposes of organizing their self-study is shifting to the university authorities. These include, in particular, the development and approval by the Academic Boards of the procedure for organizing students' self-study, the preparation of methodological recommendations for ensuring the cyber security of a modular, object-oriented Moodle environment, instructions for organizing technical protection of information in the appropriate system, etc.

Local regulatory instruments, in our opinion, should involve the following provisions: 1) general requirements for technical security of information and methods of secure authentication in LMS MOODLE should be identified; 2) key features of cyber risks and cyber threats for LMS MOODLE's

users and its technological components should be clarified; 3) an exceptional list of cases where the MOODLE programme code can be modified at the level of an individual university or its main structural units should be created; 4) a system of legal, technical and organizational means to address the threats for LMS MOODLE in the part of organizing students' self-work should be developed.

The resolution of the issues outlined in local acts helps to determine, first of all, the measures for the legitimate use of intellectual property objects in LMS MOODLE, as well as the legitimate processing of personal data of its participants. At the same time, effective local regulation for LMS MOODLE application for the organization of students' self-study allows us to distinguish the role competence of all categories of system participants, as well as to determine risks and threats to their cybersecurity due to local technical mistakes.

6. Practical implementation

The conducted research on the educational, technological and legal aspects of students' self-study organization by means of LMS MOODLE allows us to formulate the following provisions of their practical implementation in educational process:

The organization and management are provided by means of administrative instruments of the system [35,36]. By using such instruments as Outcomes and Scales, a teacher knows not only when the work is completed but also how much time it takes for each student. Figure 3 illustrates the application of such LMS MOODLE instrument as Outcomes.

Ім'я / Прізвище	Електронна пошта	Стан	Розпочато	Завершено	Затрачений час	Оцінка/8,00	Пит.1 /2,00	Пит.2 /2,00	Пит.3 /2,00	Пит.4 /2,00
Катерина Воркуєва Перегляд спроби	katerinalife1513@gmail.com	Завершено	9 квітень 2018 3:22	10 квітень 2018 2:43	11 години 21 хв	8,00	✓ 2,00	✓ 2,00	✓ 2,00	✓ 2,00
Вероніка Лазоренко Перегляд спроби	ltn2008@ukr.net	Завершено	9 квітень 2018 10:21	9 квітень 2018 10:53	31 хв 31 сек	8,00	✓ 2,00	✓ 2,00	✓ 2,00	✓ 2,00
Анастасія Гридасова Перегляд спроби	anastaccloud@icloud.com	Завершено	10 квітень 2018 1:33	10 квітень 2018 3:59	2 години 25 хв	8,00	✓ 2,00	✓ 2,00	✓ 2,00	✓ 2,00
Поліна Клименко Перегляд спроби	Polinakylenko2000@gmail.com	Завершено	11 квітень 2018 4:17	11 квітень 2018 4:32	14 хв 23 сек	5,00	✓ 1,00	✓ 1,00	✓ 2,00	✓ 1,00
Ілля Горобець Перегляд спроби	lhorobets2000@gmail.com	Завершено	15 квітень 2018 12:04	15 квітень 2018 12:41	37 хв 40 сек	8,00	✓ 2,00	✓ 2,00	✓ 2,00	✓ 2,00
Дмитро Дідусь Перегляд спроби	didusdima@ukr.net	Завершено	24 квітень 2018 11:11	28 квітень 2018 10:52	3 днів 11 години	6,00	✓ 1,00	✓ 1,00	✓ 2,00	✓ 2,00
Олександра Асташева Перегляд спроби	astashvaalex@gmail.com	Завершено	25 квітень 2018 8:22	30 квітень 2018 2:12	5 днів 5 години	6,00	✓ 1,00	✓ 1,00	✓ 2,00	✓ 2,00
Владим										

Figure 3: Screenshot of LMS Moodle Tool - Result

The presentation of new learning material and the evaluation of the results are provided by such LMS MOODLE instruments as Lesson, Task, Glossary, Survey, Test, Workshop. The teacher is able to present new learning material in an attractive and flexible way using different electronic formats. It is also possible to evaluate students' performance and comment on their work. It is the teacher who sets the deadlines for performing the task, a number of attempts and the possibility for its redoing. Figure 4 illustrates the application of such LMS MOODLE instrument as Test.

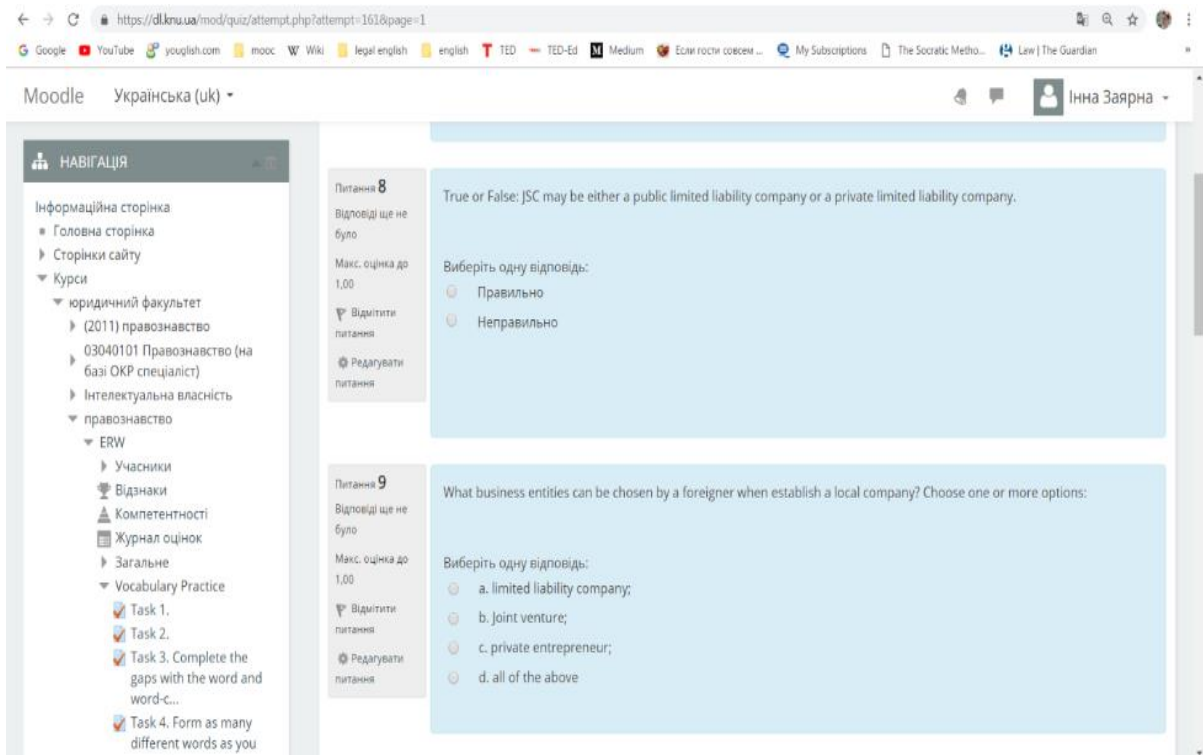


Figure 4: Screenshot of LMS Moodle Tool – Test

Significant advantage of LMS MOODLE is its facilities for cooperative learning which is provided by such LMS MOODLE communicative instruments as Wiki, Forum, Chat, Message, Workshop. These instruments allow organizing students' cooperative activity, dividing them into groups, working synchronously and asynchronously. All conversations and notes are kept on the platform and are available for their further analysis and evaluation. Figure 5 illustrates the application of such LMS MOODLE instrument as Wiki.

7. Conclusions

Due to the absence of unified state policy of digitalization of education, it is necessary to unite efforts to create a unified state policy of ICT-based education transformation with a single strategic vision, clear indicators and effective management of this policy regardless of change of government and individual performers; to remove legislative, institutional and other obstacles that hinder the development of digitalization of education; to develop a roadmap for digitalization of education, in general, and a phased roadmap for digitalization of higher education institutions; to develop an index of digital readiness of all educational institutions, the inclusion of indicators of this index in the conditions of accreditation of educational institutions and certification of teaching staff; develop a plan for broadband access to Internet educational institutions, promote the introduction of digital document management and digital services in the education system, recommend the implementation of educational projects on information security, cybersecurity, protection of personal data and rights of digital users in distance learning, introduce new professions and disciplines related to the Internet of Things, cloud computing, machine learning, artificial intelligence, robotics, augmented reality, need to apply modern tools in the form of editors of ontological scenarios of the knowledge base [34], etc.

An important aspect in the preparation of training sessions in the Moodle system is the independent work, the methods for preparation of which are described in the paper.

Simultaneously, the widespread use of the Moodle system for the purpose of organizing students' independent work requires the solution of the problems set that are covered by the educational, tech-

nical and legal aspects of the application of the relevant information system. Among the main ways to solve such problems, the following should be mentioned:

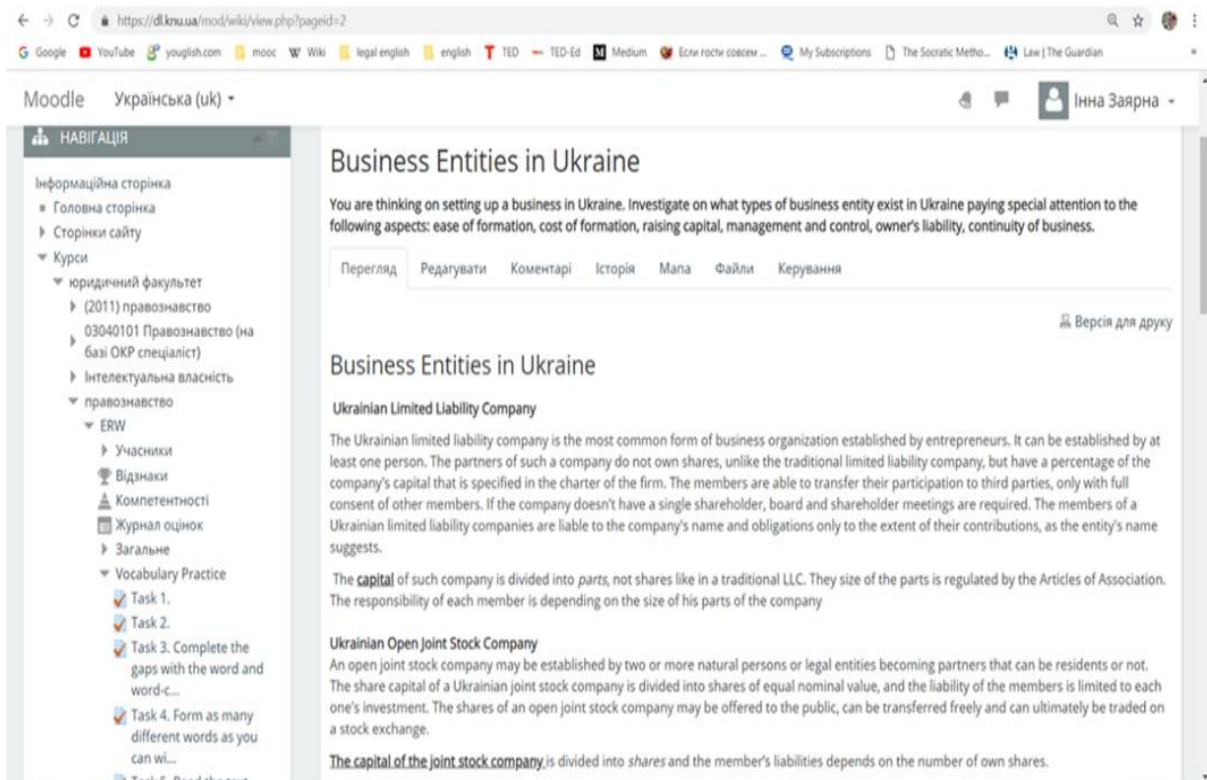


Figure 5. Screenshot of LMS Moodle Tool - Wiki

- 1) ensuring that teachers make the right choice of methods for organizing independent work on the Moodle platform;
- 2) ensuring the complete, prompt filling of the system with topical content that meets the goals of students' independent work;
- 3) ensuring that the source code of the system is modified only in the cases provided for in the Moodle-based institution of higher education;
- 4) approval by the administrations of higher education institutions of the procedure for processing personal data of Moodle participants;
- 5) the development and approval by the administration of higher education institutions of the instructions for technical protection of objects in the Moodle system.

Applying these methods to increase the efficiency of the Moodle system will help ensure the security of users of the relevant system and relevant digital content, as well as ensure the cyber security of the system as a whole.

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