

Virtual learning environments: major trends in the use of modern digital technologies in higher education institutions

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Abstract. The article reveals the features of development and integrated implementation of virtual learning environment with the use of modern digital technologies in the learning process of higher education. The article summarizes the interpretation of the concept of “virtual learning environment”. Virtual learning environment can be interpreted as an immersive online learning environment that has a methodologically integrated learning system, provides an open interactive dynamic learning process in cyberspace using modern digital technologies that take into account the individual educational characteristics of students. The main subjects and functions of the virtual learning environment are identified. One of the links in creating a virtual learning environment is the development of free learning space through websites. It is stated that the teacher’s site should be integrated into the learning technology designed and implemented by the teacher. Then the logic and structure of the lesson will be an element of the teacher’s creativity, and he is able to choose his own strategy and teaching methods, and not just follow the presentation of the material proposed by other authors. In conditions when the idea of personality-oriented learning, built on the innovative activities of the teacher, is fundamental in education, this approach, according to our research, is crucial. The possibilities of modern network technologies involved in the content management system are described, the roles of participants in the educational process are determined, the tasks solved by educational platforms are indicated, their main functions in the learning environment of higher education institutions are described.

Keywords: virtual learning environment, teacher’s website, learning management systems, educational process, higher education applicant

1. Introduction

Today’s digital technologies have a significant impact on people and society. They are changing the way we think, perceive, and act. The way we learn and teach is significantly affected by technological change because the technologies that we use for education are constantly evolving and changing. Digital technologies give rise to the improvement of the forms and methods of interaction between the participants of the educational process. Of particular

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importance are virtual learning environments, in the pedagogically weighted use of which we see opportunities for integration into the traditional information and learning environment of a higher education institution. The flexibility of using digital technologies in organizing the learning process requires proper selection of teaching tools and content in accordance with didactic properties and possibilities of online environments; forecasting the possible impact of the latest technologies on the nature of thinking and behavior of participants in the educational process.

The introduction of innovative technologies of remote learning in higher education is one of the operational goals, the objectives of which are to create an industry of innovative technologies and learning tools that meet the world scientific and technological level; digitalization of all processes in higher education; remote learning normalization as a form of higher education [27]. Through quarantine constraints fundamental priorities, which include the organization of the educational process regardless of time and location of its participants, ensuring interactive work of students with educational content, adaptation of the learning process to the individual characteristics, needs and characteristics of applicants for education, the use of e-learning tools and services have acquired wide practical meaning. There are configurations in the ways and developments of learning, including the role and place of teachers [26]. From traditional teaching, broadcasting, transmission and control of knowledge functions of educators are transformed and focused in the creation and functioning of the learning environment and its management with the extensive use of digital technologies in full-time, part-time, dual and mixed forms of education and active student participation; self-education, internships, professional development, participation in grant programs and other projects, etc.

Thus, new requirements are put forward for educational institutions to prepare responsible individuals capable of adapting to modern society for adult life. Hence, one of the main objectives is to create the conditions for each graduate to receive the level of education that suits his/her abilities, interests and capabilities. It is by means of modern digital technologies in a remote learning environment, teachers direct their efforts to provide students with individualized learning pace, differentiated complication of training material and development of individual tasks, taking into account students' interests and in accordance with the profile of the educational institution. The effectiveness of such training will increase significantly with the use of digital and information and communication technologies, which will provide significant opportunities for expanding the educational process in accordance with the cognitive characteristics of higher education applicants.

2. Related work

Virtual learning environment is a subject of scientific research in number of studies. Falshtynska [3], Krasilnik [12], Pererva et al. [20], Skurativska and Popadiuk [23], Tryus, Herasymenko and Franchuk [28] investigated the problem of virtual learning environment application as a necessary component of the educational process in higher education. Hendrickson [4], Husak and Radzikhovska [8], Osadcha et al. [17], Verstege, Vincken and Diederer [31] analyzed the features of teaching natural and mathematical subjects in higher education institutions using virtual learning environment facilities.

Pakhomova and Bondarenko [19] analyzed the concepts of “virtual learning environment”, “virtual educational environment”, “electronic learning environment” and others.

Smutny and Schreiberova [25] note the availability of learning chatbots as a popular option for virtual interaction with students. Researchers found 89 unique educational chatbots in the instant messaging application Facebook Messenger and evaluated the performance of 47 of them as learning support tools. The educational chatbots on the Facebook Messenger platform range from a basic level of personalized messaging to recommending educational content. These findings provide further evidence that chatbot programming (especially Facebook Messenger) is still in its early stages. Additional features include artificial intelligence learning assistants that answer typical questions posted by students, set learning goals and monitor learning progress.

McLaren et al. [15] have investigated how learning contexts using educational technology can affect learning, specifically looking at how lessons can be conducted using a digital learning game. In a typical classroom setting, the instructor acts as a learning leader and facilitator as students use the software to learn. Students submit to the instructor’s expectations and are under the pressure of limited time, as classes are usually of a certain length and held at certain times of the day. Completing academic tasks at home gives students much more independence with a variety of learning and technical support from parents, professors, classmates, and upperclassmen. The level of noise and focus during homeschooling can vary greatly, depending entirely on each student’s home environment. Students can often work at home whenever they want, day or night, and for as long or as fast as they want. They are also much less subject to rules, except those imposed by their parents, and those rules may differ considerably from those of teachers.

Verstege, Vincken and Diederer [31] developed a plan to create virtual experimental environments for laboratory-based learning that play an important role in university-level science curricula. The researchers established three general design requirements applicable to virtual learning environments for organizing laboratory instruction: 1) create a positive learning experience; 2) support students in achieving the intended learning outcomes; and 3) allow students to complete assignments independently. The paper presents general design requirements, design principles, and design architecture that can be used as a blueprint for creating virtual experimental environments. In addition to establishing the three general requirements, fourteen relevant design principles and design architecture are proposed based on ideas gathered from educational design research.

Smulson [24] considered the psychological problems of creating virtual learning environments as self-development environments. The properties of immersive environments important for the design of virtual educational space are analyzed. Smulson [24] notes the methodological integrity of the learning system in a virtual environment, in other words, psychological, pedagogical, didactic, methodological and technological unity of the approaches to learning design and appropriate learning impacts, multiple interaction of subjects of the learning process in the environment.

With the development of immersive technologies in education [1, 22], it became possible to effectively provide virtual environment for the organization of training in computer science and mathematics of applicants for higher education: a wide range of digital technologies offers new opportunities for learning material, monitoring the pace of training activities and the level of training of each student.

Vaindorf-Sysoeva [30] considers virtual learning environment, in particular, as a set of information content and communication capabilities of different types of computer networks, which are formed and used for training participants in the educational process; information space for interaction between participants in the educational process, which is provided by information and communication technologies and contains a set of digital tools that manage the content of the learning environment and communication participants.

Smulson [24] notes the emergence of a new approach to learning, focused on an immersive learning and professional environment, i.e., non-subjective spatial localization and autonomous existence, synchronized environment, vectoriality, integrity, motivationality, immersiveness, presence, interactivity, etc.

Zhuk and Sirenko [32] understand virtual learning environment as a network communication space, which provides the organization of the educational process, its methodological and information support, documentation, interaction between all subjects of the educational process (students, teachers, dean's office), and its management.

So, virtual learning environment can be interpreted as an immersive online learning environment, which has a methodologically holistic learning system, provides an open interactive dynamic learning process in a virtual space using modern digital technologies, taking into account individual educational characteristics of the student.

Virtual learning environment is aimed at improving the learning process and providing free access to training materials of theoretical and practical field, electronic library with a selection of recommended literature, teacher consultations and communication with classmates through general and private chats, performing interactive tasks, etc. Hrinchenko [6] considers a virtual educational-and-methodical complex consisting of: instructional unit, information unit (resource content system), control unit (testing and evaluation mechanism), communication unit (interactive teaching system) and the control system combines all this together. Combining these blocks into a single virtual system will ensure the study of the academic subject as a holistic process, including lectures, seminars, practical and laboratory classes, individual and group consultations, control activities and independent work of students.

Lipeikiene [13] defines a virtual learning environment as software hosted on a particular server and designed to manage various aspects of learning: course management mechanism, student progress monitoring and assessment, access to resources. Lipeikiene [13] defines the main requirements for a virtual learning environment: access control – usually based on the creation of an account containing a user login and password; creation of professional course material and mastery of management skills, the course learning content can change over time: updated or effectively supplemented; ensure the use of all types of multimedia content: text, 2D and 3D graphics, animation, digital audio and video, virtual reality; text, 2D and 3D graphics, animation, digital audio and video, virtual reality; links to digital libraries and other important information on the Internet; automated glossaries, indexes, search engines; communication tools – email, chat rooms, presentations, announcements, discussions within the environment; connection to software required for learning (if available); personal space for students to share and store materials; tools for automatic assessment, usually also self-assessment tools; monitoring the progress of students, the systematization of their grades, statistical information about the learning process for the teacher.

Sarafanuk [21] believes that the key properties of virtual learning environments include:

immersive learning environment in which one is immersed; interactivity (active user interaction with the artificial environment); dynamism (rapid change of events); imaginary; sense of presence (experiencing sensations identical to reality); continuity (possibility of infinite representation); temporality and causality (rotating time; activation of causal relationships: for example, the presence of multimedia accompaniment of answers allows the student to observe and comprehend the consequences of their actions and decisions, to experience them as real, to predict the possible development of events).

Virtual learning environments also act as elements of adaptation and modeling of students' activities, because adaptive learning systems should build the educational strategy of the applicant with personalization in mind. Typically, personalization implies adaptive interaction, adaptive access to the course, adaptive content of the training material, and adaptive collaboration support. The origins of adaptation technologies used in learning adaptive systems come from the field of information learning systems (adaptive planning, data mining, interactive task execution support, ready-made example task execution support, and collaboration support) or from the field of adaptive hypermedia systems meeting three criteria: the hypermedia system must be hypertext or hypermedia, have a user model and adapt its hypermedia space using that model.

Osadcha et al. [17] concretize the goal of adaptive systems of individualization and personalization of professional training of future professionals in a blended learning environment in the following tasks: 1) to implement adaptive learning technologies in higher education institutions: adaptation of learning materials, adaptation of control (testing), adaptation of devices, adaptation of face-to-face classes; 2) to introduce an individual approach in the process of professional training in the system of remote and full-time education through the study of individual qualities of students, support and maintenance of the individual training program of the student, individualization of the learning process, development of individual characteristics of the student and the formation of new characteristics on his educational request, monitoring of individual progress; 4) implement a systematic use of modern information and communication technologies and modern technical means of education in order to provide professional training of future specialists in a mixed learning environment; 5) monitor the formation of professional competence of future specialists in the adaptive system of higher education.

Virtual learning environment is a creative environment, learning in which is possible in the presence of high intrinsic motivation of students, their positive mood. The implementation of personality-centered educational system is a necessary condition for learning in virtual learning environment. The degree of confidence of teachers in the initiatives of students in such a system is higher than in the traditional system of education. Digital technologies act as an important component of providing an effective learning process for creating conditions for productive creative activities, which provide thorough opportunities for students' self-realization.

Virtual learning environments are designed by means of a modern learning management system (LMS), which is a web-based application that allows for the administration of educational content in the distance learning process. The presence of a convenient learning management system allows you to solve a number of problems that previously required a large number of disparate tools.

According to Dobre [2], Turnbull, Chugh and Luck [29], LMS or web-based learning system that allow instructors to create, manage and communicate course content. LMS play an impor-

tant role in improving and supporting remote and mixed teaching and learning in today's digital environment. LMS can provide interactive tools such as blogs, wikis, chat rooms, and discussion platforms that allow virtual learning environments to develop constructivist approaches to learning.

The main functions of LMS are: registration of students and teachers; delivery of training content; providing various types of interaction of students with each other and with teachers; progress control; collection of statistics on learning activities; generation of reports, etc.

Virtual learning environment is created by means of LMS to solve problems of administration, schedule management; placement of content that takes into account the educational characteristics of the student; different types of tracking of tasks and history of the student to provide individual training. The main functions of LMS are class organization, implementation of collaborative learning, attendance management and availability of bulletin board.

Mershad and Wakim [16] presented an IoT-based learning management system in which different types of components such as remote lectures, classroom monitoring, virtual reality, classroom experimentation, security, classroom tutorials, student assessment and data sharing have been reviewed and improved/updated. They note that this improved LMS will provide students, faculty, and administrative staff with a positive experience when participating in e-learning courses or performing administrative work. Their LMS model takes into account the importance of system efficiency and effectiveness, but also focuses on collaboration and interaction between all parties involved.

Jung and Huh [9] explain the basic structure of a LMS in figure 1. Students access the LMS web server using a web browser. The LMS web server provides a VoD (video on demand) service according to the student's request and then allows the student to view and edit their information (user information) or provides a mobile web service according to the user's environment. In addition, various functions necessary for online learning, such as messages, frequently asked questions and online textbook purchases, are stored in a database. Meanwhile, the LMS displays information useful to students, including external data such as weather information and online course news, as well as information provided by the LMS's own database.

Osman [18] notes that the learning management systems in use today are either commercial products (e.g., WebCT, Blackboard, SAP Litmos, 360Learning, Opigno LMS, Fuse Next-Gen Learning, Collaborator) or free and open source products (e.g. Moodle, ILLIAS, Neo LMS), or customizable software systems that serve the learning goals of certain organizations. LMSs in the first and second categories are exponentially increasing as most institutions and universities use off-the-shelf LMSs. This is due to the complexity of developing such systems.

Moodle is one of the most widely used learning management systems nowadays. Moodle is a free open learning management system, which provides the implementation of the educational process in blended and remote learning modern digital means of communication between teachers and students, which is implemented in the form of Internet conferences, discussions, forums, etc. This adaptive learning system allows you to create high-quality remote learning courses, as well as provide support in the format of face-to-face learning. Moodle system has secure access through pre-registration and getting an individual login and password.

When attaching text files to Moodle pages for import, it is necessary to reformat them to create a SCORM package. The SCORM package is a zip archive in which all the learning materials are packaged. The LMS then not only gives students access to these materials, but

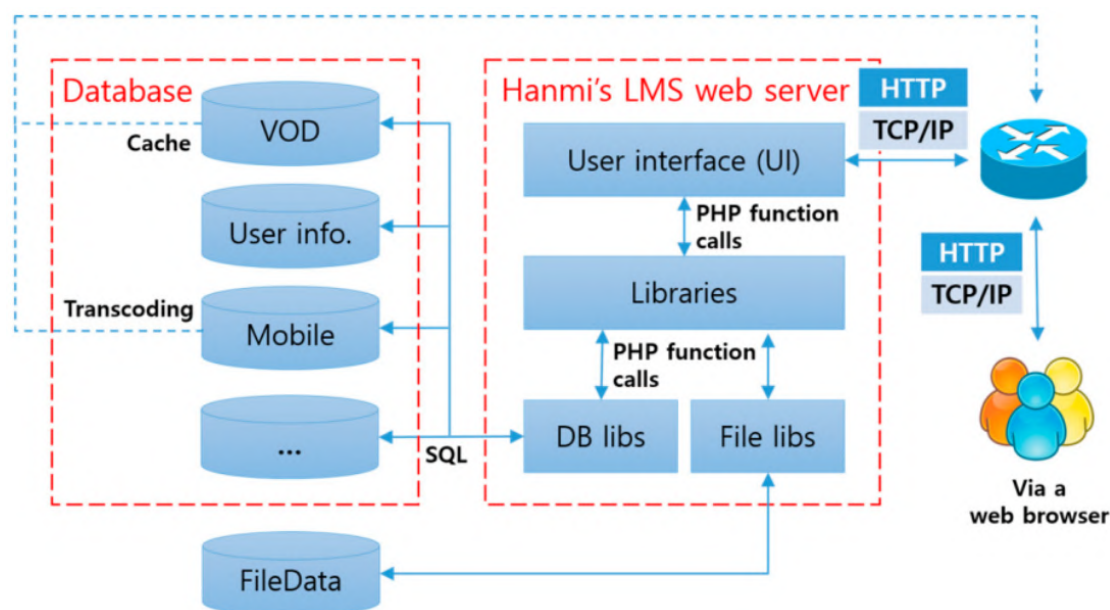


Figure 1: Structure of a basic LMS [9].

also keeps all the learning statistics. Support of SCORM standard is one of the main advantages of Moodle, which allows for successful integration of this LMS with other learning platforms.

The advantages of Moodle are in the fact that the LMS [7]:

- has an open source code that allows to adjust LMS to the specifics of the educational process of a particular institution, develop additional training modules and if necessary, integrate with other virtual learning environments;
- allows to organize learning in an active form, with the joint solution of academic tasks, mutual exchange of knowledge;
- realizes different ways of communication: forum, chat, internal mail, exchange of files of any formats, mailing list, possibility to review students' works, etc.;
- possibility to use different evaluation systems;
- full information about students' success and their work;
- program interfaces allow students of different educational level, physical abilities and cultures to work.

The developers of LMS Collaborator note that it is a functional platform for adaptation, training, certification and development of company personnel with flexible integration capabilities.

Hlukhaniuk et al. [5] specify that LMS Collaborator is a system of remote learning ("collaborator" from Latin "employee"), working round the clock on all devices of SaaS platform - from PC to cell phone and allows the following tasks:

- content creation and import,
- user management,

- training according to the program content,
- notification, informing and providing corporate knowledge base with delimited access rights,
- testing and attestation of students,
- integration of participants in the educational process,
- curricula of academic subjects and syllabuses,
- reporting on the activity and educational development of students in real time,
- conducting classes, consultations and training through webinars [14].

Kosovets et al. [10] analyzes LMS Collaborator as an adaptive learning system for mathematics and computer science, which provides optimal adaptation of the educational process to the individual characteristics and personal preferences of the student, helps to activate their cognitive activity, increases motivation for learning, makes it possible to monitor learning and adjust it to achieve the planned individual results. Adaptive learning system implemented by means of LMS Collaborator has the potential to ensure the full involvement of students in the process of building their own individual educational trajectory, development of their activity, improvement of individualization of the educational process, etc.

LMS Collaborator strengths:

1. *System management.* Management of users, roles and access rights, import and integration with human resources systems, access and action control.
2. *Organization of automated learning and monitoring of student progress.* The system is set up for automated training by setting up step-by-step access to structured training materials (training materials of different types, tools for organizing practical training, internal testing systems, set up reporting module). Organization of training content in LMS Collaborator assumes alternation of training material and certain forms of knowledge control (tests, practical tasks).
3. *Monitoring the progress and activity of higher education applicants.* The system has a built-in specialized module to monitor the progress and activity of students and the intensity of work in the system of subjects of the learning process, thanks to which the tutor / administrator can monitor the learning activities of students, regulate their interaction, which increases the interest of users in active interaction and ensures the objectivity of evaluation.
4. *Communication and cooperation with the system developers.* Administrators cooperate with the developers of the system, report inaccuracies in the work, consult on the correct setting of certain modules.
5. *Ergonomics and mobility.* The system works on all modern devices, adapts to tablets and smartphones, a browser and Internet access are sufficient.

3. Results

Thus, the use of modern digital technologies in education has led to the emergence of a virtual learning environment, within which continuous self-realization and self-development of an

active and creative personality is possible in the organization and functioning of educational systems with realized openness, integrativity and adaptability.

The main subjects of virtual learning environment are:

- *student* – virtual learning space fundamentally changes the paradigm of learning from teacher-centered to student-centered model, characterized by the student's ability to analyze, synthesize, evaluate, self-assess, self-development, reflection, etc.;
- *teacher, teacher-curator, methodologist, tutor, facilitator* – develops or uses the existing training course, conducts online classes and consultations, checks and evaluates the work of students, coordinates the whole educational process, helps students during the work in the software environment, ensures successful group communication;
- *administrator, programmer* – IT specialists, who ensure the functioning of the learning management system, have access to all the resources of the system.

The educational process is dominated by interactive self-learning with constant feedback in the teacher-student system, and the organization of independent work is aimed at developing the skills of creativity, cognitive activity and systemic thinking of the subjects of training through the creation of a virtual learning environment. The important components are ensuring expediency of learning by maintaining the priority of learning over teaching; dominance of activity-based type of learning; organization of independent learning activities; increasing motivation for learning through the use of means of complex presentation and manipulation of audiovisual information; increasing the level of emotional perception of information and formation of abilities to implement various forms of independent activities for information processing. Therefore, one of the links in the creation of virtual learning environment is the development of free learning space by means of websites.

The peculiarity of modern specialist training is that today's student is formed in an information society and is able to receive information himself/herself through electronic resources. However, there is a great need to teach him/her to quickly search for the necessary information, work through, assimilate and use it to understand the educational material. To this end, we see the effective use of the teacher's personal website in the learning process.

The requirements for the site are consistent with the functions it should perform: informational, developmental, formative, educational and managerial, and subordinate to the triad "student → textbook / website → teacher". In this case, the teacher's role is significantly strengthened, because it is here that the teacher teaches students to independently search, analyze and process new information. Therefore, the teacher's site should be integrated into the learning technology that the teacher designs and implements. Then the logic and structure of the lesson will be an element of the teacher's creativity, and he/she will be able to choose his/her own strategy and teaching methodology, and not just follow the presentation of material proposed by other authors. In the conditions when the idea of personality-centered learning, built on the innovative activity of the teacher, is fundamental in education, this approach, according to our research, becomes crucial.

Using the capabilities of modern networking technologies allows:

- optimizing and structuring information according to criterion norms that are accessible to the user and will greatly facilitate the search for the necessary data;

- introducing interactive means of interaction between a user (student) and a certain structural unit of a common training complex, which, in turn, allows the following varieties of learning activities to be automated: testing, with tests being as varied as possible, from the simplest optional to complex step-by-step calculations; conducting experience in conditions close to the laboratory, without wasting educational institution resources on their practical implementation;
- introducing interactive means of interaction between the user (student) and the teachers accompanying a particular structural unit of the general training complex and their fellow students (feedback forms, thematic forums on the resource platform, the possibility of uploading their files to the resource);
- using a multilevel system of access to a certain kind of content and possibility of fast attaching of accessibility levels to the contents of databases. This approach allows the implementation of an interesting system for working with groups of students, for example, a test work, which will be available only to users with logins to a specific group and for a certain period of time. Similarly, a student's personal account is realized where he can revise his results, assigned tasks, deadlines for individual works; in fact, we have an electronic organizer in education where the main tasks are assigned by the manager of the learning process;
- using video content, webinars, conferences, etc.

The platform is designed for further expansion and has a non-static structure. At present we can clearly define the distribution of roles of project members when using an electronic resource, which allows you to clearly define the range of work to be performed directly by teachers, graduate and undergraduate students, and major opportunities for students and applicants to use educational materials to acquire new knowledge, as well as to check the material they have learned.

The role of the site administrator:

- changing the structure of the site, adding new structural units;
- granting users access rights, creating new levels of access;
- changing the interface of the site or its individual structural units;
- developing an electronic version of test systems based on the described algorithm.

The role of the content manager:

- creating and adding new materials;
- creating test systems at the algorithmic and descriptive level for further implementation;
- viewing the results of tests, surveys and other results of feedback from the teacher to the students;
- assigning for viewing mandatory materials to certain users or groups
- analysis of results and determination of recommendations for research on certain topics for individual user groups.

The role of the user (student/graduate student):

- viewing materials (texts, animations, videos, etc.);
- taking tests (optional and as assigned by the teacher);
- reviewing test results, results of work in classrooms exported by the teacher;
- communication on the forum, communication with the teacher, graduate student, supporting section in the methodological plan.

Regarding the use of information and communication technologies, we note that in today's society, it is network technology that is becoming a driving force for new technical and methodological developments. On the basis of ICTs, ways of supporting the educational process are being created, including reference books, text and graphic materials, and training systems [11]. On the virtual learning environment we created 10 years ago, namely on the teacher's website <http://www.kovtonyuk.inf.ua/>, there is a standard list of materials for this type of structures: news; electronic manual (for independent processing of theoretical and practical material, created on a hypertext basis, which allows the student to work on an individual training path); file section (here additional materials are available to site users); exhibitions (an opportunity to show the best student teaching and research projects); information about the project supervisors in general and individual sections; a gallery of photos from conferences, competitions, defense of theses etc.

The electronic textbook is an electronic version of the textbook on mathematical and functional analysis, differential equations, designed for use in training, contains 9 sections. All teaching materials are intellectual property of the author and are published in the tutorial and methodical works. The site is open access, so it can also be used by students from many countries who speak Ukrainian.

As for general statistics of visits by users of the site, we note that their number varies from year to year and from month to month. For example, in 2015 the number of sessions (monthly) averaged 400, at the end of 2016 – 700–800, in March 2017 – 1084, in March 2022 – 232. The qualitative composition of visitors is also changing.

Thus, in March 2022 the site was actively visited by 62.11 % of users from Ukraine, 8.42 % from the U.S., 7.37 % from China, 7.37 % from the UK, 2.11 % from Poland, 2.11 % from India and 1.06 % from France.

We have begun preparing a new English-language version of the e-textbook Calculus and Differential Equations: a self-study guide. Here is an English version of lectures for Ukrainian-language e-textbook (figure 2). For this year we plan to translate two sections so far: "Single Variable Calculus. Differentiation" and "Single Variable Calculus. Integration". Teachers, post-graduates and students of the Vinnytsia Mykhailo Kotsyubynskyi State Pedagogical University participate in the project.

Thus, the practice of using the e-textbook posted on the teacher's website has shown that the combination of remote methods in a virtual learning environment with traditional forms and methods of training can be effective and promising, provided they are balanced. As for the prospects of the site functioning, we consider two directions: creation of e-textbook in a foreign language (in English, possibly in Polish) and transition to a new platform, which will allow using the site on mobile devices.

The virtual learning and methodological complex of the learning environment consists of instructional, informational, control, communication blocks and a control system that brings it

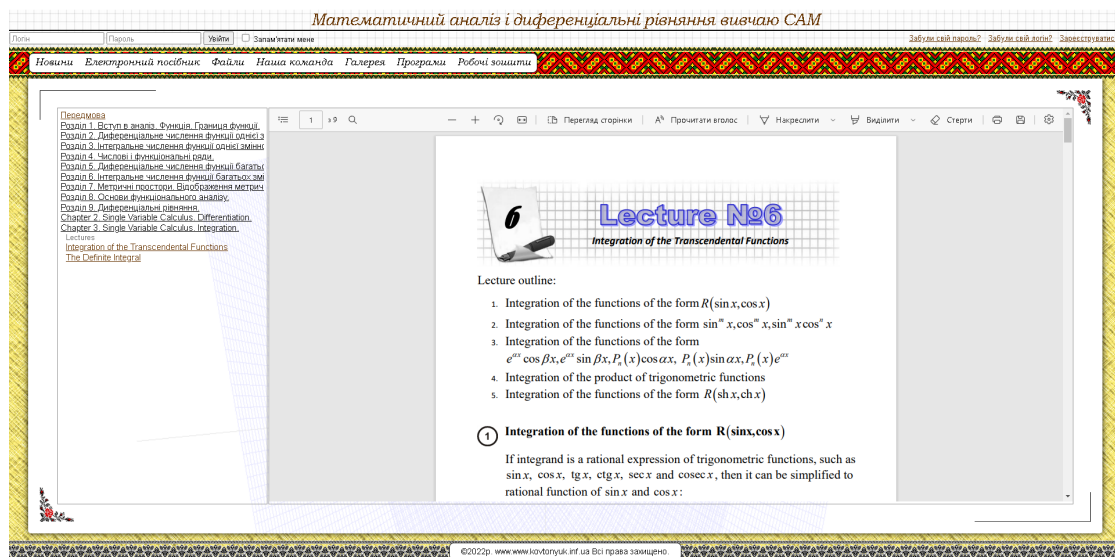
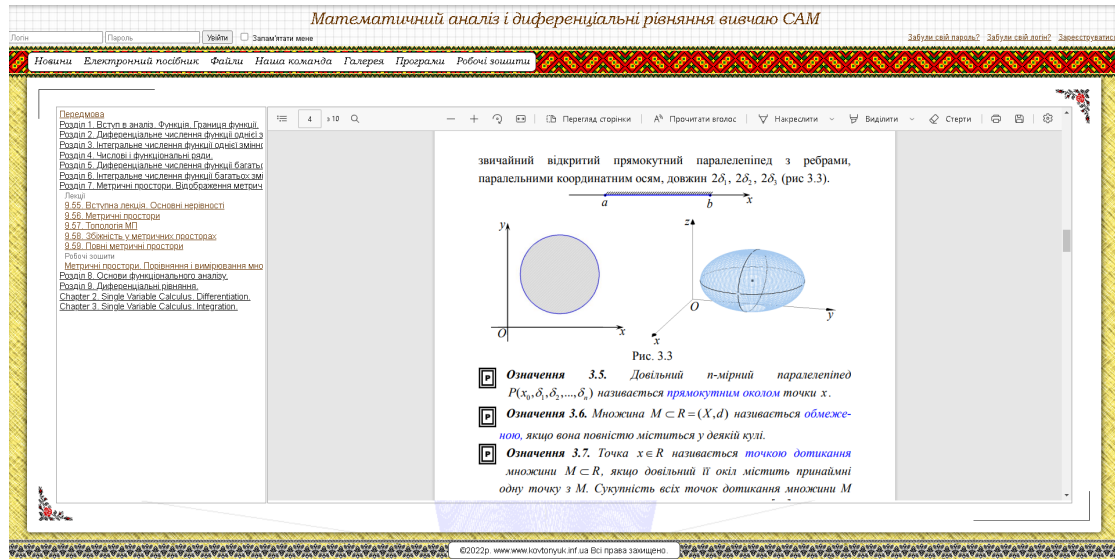


Figure 2: Educational project on the site www.kovtonyuk.inf.ua.

all together. The combination of these blocks into a single virtual system will ensure the study of an academic subject as a holistic process. Let’s analyze the presence of these blocks in LMS Collaborator and their software implementation.

1. The instructional block of LMS Collaborator contains: class schedule, general announcements on the main page, news feeds with division into headings, news archive; creation of tasks list with their due dates; individual or group assignment of tasks to students; modes of assignment due dates – unlimited, in days after assignment, in calendar period; assignment modes – self-assignment, application, forced assignment; automatic messages to e-mail, browser, SMS messages, integration with Viber, connecting Viber bots; database

- of the faculty and student contact information with search and filtering by group.
2. The information block is implemented through: training programs – it's a combination of individual training resources, tests and courses into one training program, which allows you to create learning paths by setting access rules for program elements; creation of individual training programs and courses on a combination of resources, tests and surveys, formation and customization of the course plan; directory of training tasks, consisting of program, courses, tests, surveys; creation and downloading of information resources in HTML-page format, file, web presentation, gallery, Markdown page etc. The virtual learning and methodological complex of the educational environment consists of instructional, informational, control, communication blocks and a control system that brings it all together. The combination of these blocks into a single virtual system will ensure the study of an academic subject as a holistic process. We analyze the presence of these blocks in the LMS Collaborator and Markdown page; importing training modules SCORM and HTML, presentations; converting PDF and PowerPoint presentations into web format; background conversion of video files into web format (MP4, OGG); workshops – this is the formation and distribution of tasks for independent practical work, individual counseling, exchange of files and checking the task results with grades; webinars with Microsoft Teams, eTutorium, BigBlueButton – scheduling face-to-face classes (date, time, place), attaching files for the class, scoring; availability of internal public encyclopedia; automatic formation of an information base, search for resources, wiki-articles, news, correspondence in the forum, report on the use of the Knowledge Base.
 3. The control unit contains evaluation mechanisms: tests: seven types of questions (single, multiple, free response, ordering, classification, matching and selection of area on the image), import of questions from a text file and different testing modes; comprehensive testing is the organization of general testing on given topics with the analysis of results on each topic separately; evaluation of training programs, workshops; survey and voting; reports on passing courses, testing, on training programs, surveys; a summary report of user training for the selected tasks for the period.
 4. The communication block of the interactive teaching system: announcements to a group of users (automatically and manually) with feedback. Types of announcements – notifications and messages with confirmation “I am familiar with” or “participate / possibly / no”; forum: real-time updating of forum messages, ratings of comments and participants, inviting new participants, attaching files; creating closed forum topics with restricted access, only participants can see the topic and its messages, all information is encrypted, discussion in real-time chats, group and personal communication channels, attaching files and browser messages, search by chat, commenting mode in teaching assignments.
 5. Management system to implement adaptive learning: learning trajectory is implemented through the automation of the learning process, flexible creation of adaptive learning trajectories; creation of individual development plans by setting up templates personal development plans for different areas and evaluation of the plan by the manager, curator, self-assessment; restricted access to the directory for specified user groups; restricted access to resources, setting up resource access groups by a combination of features city, division, position, label; control and management of comments; log of student work sessions in the system, log of references to academic tasks.

Vinnitsia Mykhailo Kotsyubynskiy State Pedagogical University introduced LMS Collaborator to organize remote learning for students. This is an internal university system of adaptive learning, which is entered through pre-registration through the administrator of the system.

Instructors at the Department of Mathematics and Computer Science, Faculty of Mathematics, Physics and Computer Science based on this learning management system successfully created and imported content in accordance with the content of the academic subject, and developed a system of computerized knowledge test and measurement of levels of student learning achievements.

In Collaborator, the instructor works in two modes: Tutor and User. In Tutor mode, teaching materials are added and students' knowledge is controlled. In the "Resource Management" section, training programs of academic subjects are loaded, separate folders with lectures, practical and laboratory works are formed in pdf, docx, pptx format, etc. In the "Task Management" section, group or individual sending of formed tasks is performed. Training reports are formed automatically according to the specified category (figure 3).

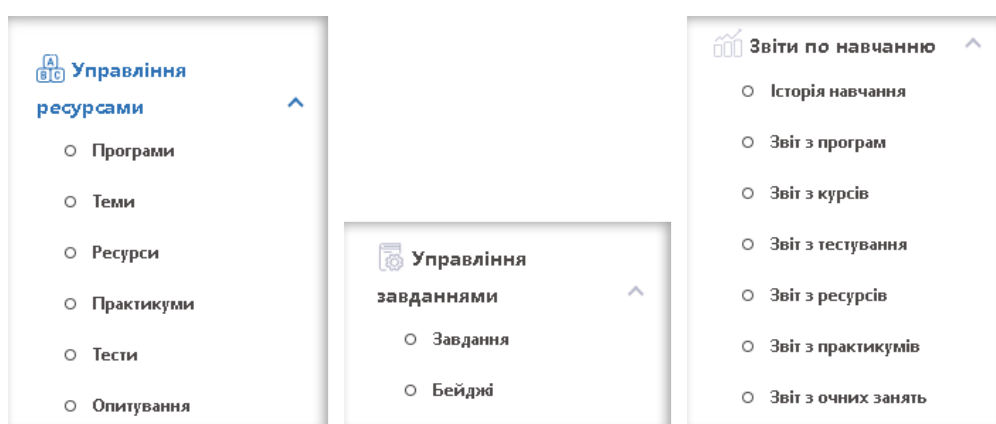


Figure 3: Tutor mode.

In the User mode, the instructor views in what form the student receives the sent theoretical material, practical tasks and tests. Tasks can be in four modes: not started with the "Pass" button, started with the "Continue" button, waiting for check with the "On check" button and completed. Depending on the type of training material (a training program with lectures, tutorials with laboratory work, tests, course, syllabus, knowledge base) the task has in the upper right corner of the corresponding icon that allows you to quickly determine the type of task (figure 4).

Created or imported learning materials in the Tutor mode through the command Resources, we recommend to allocate to individual Topics, such as lectures, labs, tests, etc., so that on the basis of the created Topics to form a complete educational and methodical complex of the academic subject through the Program. For searching of themes and resources we suggest to create tags, for example, a specialty code or group number, which will allow to filter and sort (figure 5).

Collaborator allows to form a report (figure 6) after the evaluation of all submissions or at the end of the term of the assignments. In the reports the instructor receives in a graphical

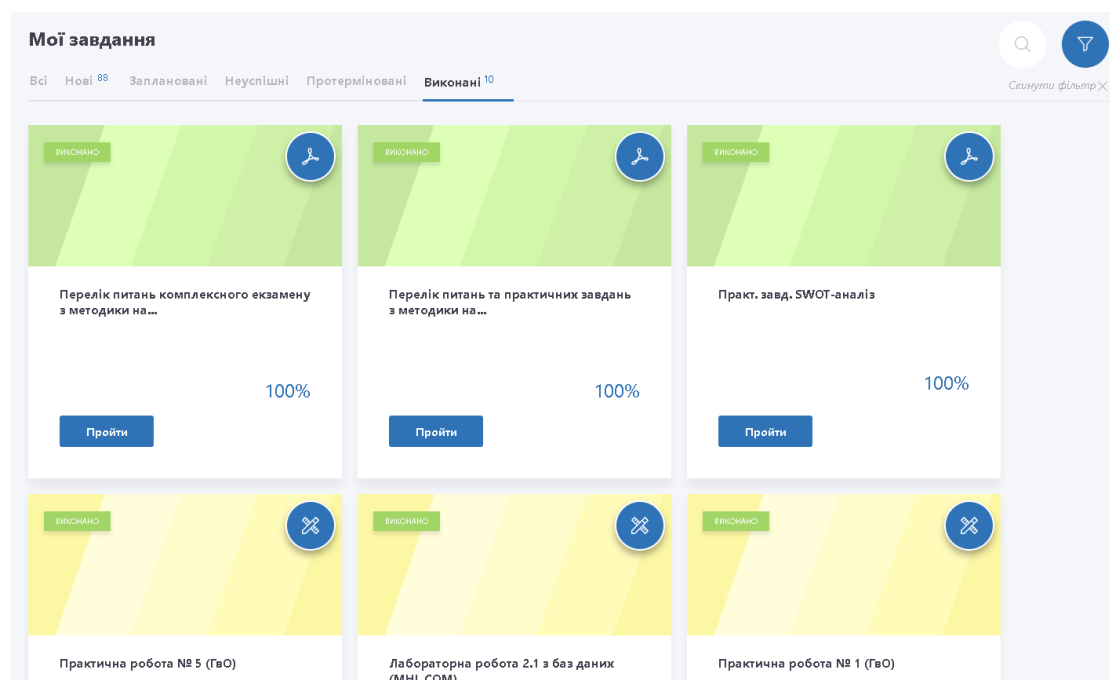


Figure 4: Student task in Collaborator.

and percentage representation of the information on the processing of theoretical training material on the academic subject, the report on the laboratory (practical) activities of students in the group, test report, report of the individual student progress (history of the student) and the summary report. Various forms of reports allow to fully assess the student's progress and monitor the formation of future specialists' professional competence in the adaptive system of higher education.

4. Discussion

Virtual learning environments implemented by means of training platforms Moodle and Collaborator provide an opportunity for teachers to create adaptive authoring remote learning courses on the curriculum of the relevant subject. Participants of the educational process get free access to learning materials, downloading files for performing tasks, tools for testing and communication, tools for group work (forums, chats, webinars, seminars, etc.), viewing the results of the training course, test results, etc. Students have access to a remote learning course on the Moodle platform and Collaborator when registering.

Compared to the Moodle platform Collaborator has easier intuitive interface to use. The Collaborator training system is also provided with a training course "Fundamentals of Working in Collaborator" for self-study of the basic principles of working with the learning management system. The system is oriented towards ordinary users who do not have special technical skills in working with the software.

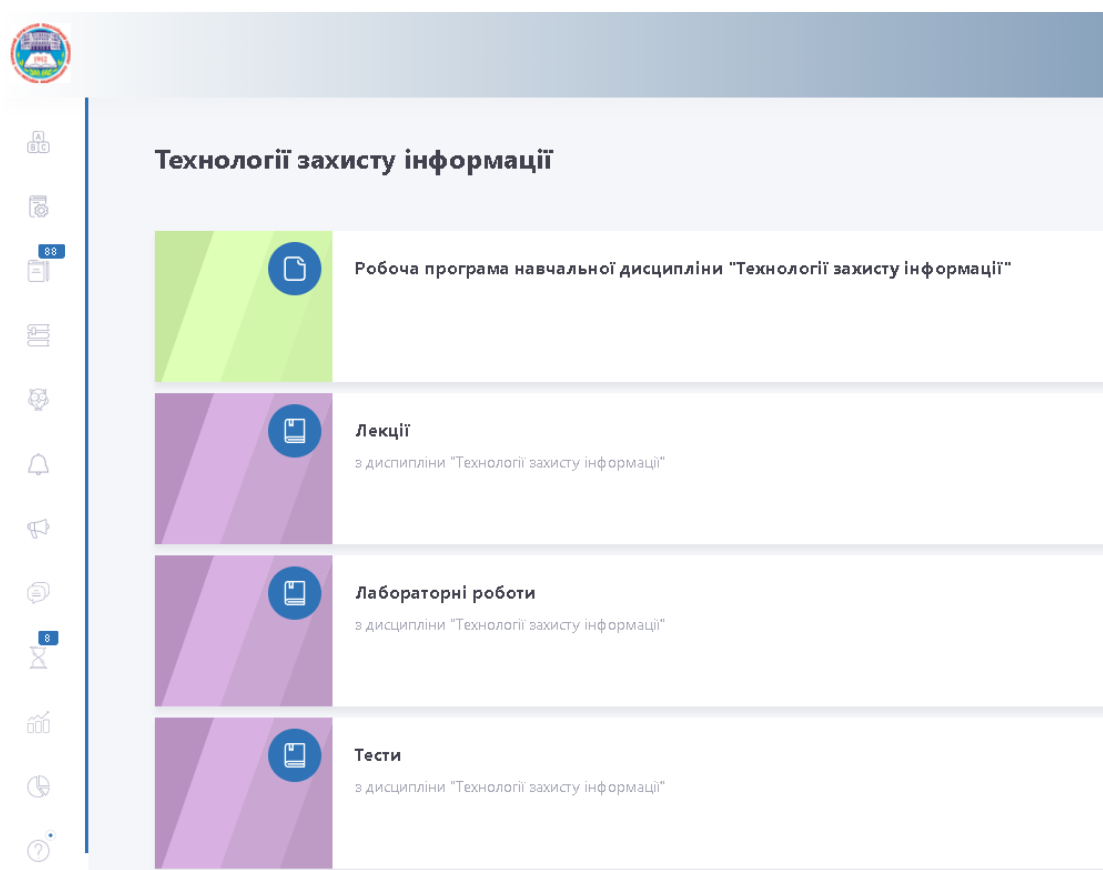


Figure 5: The educational-and-methodical complex of the academic subject in the Collaborator.

Among the disadvantages of Collaborator is the lack of grouping of tasks sent to the student by academic subjects; instructors also have some difficulties in the process of forming a task and its subsequent sending to students (especially different groups and not for the entire group), which complicates the selection and assignment of tasks.

5. Conclusion

Teachers by means of modern digital technologies in remote learning conditions direct their efforts to provide students with individualization of learning pace, differentiated complication of training material and development of individual tasks, taking into account students' interests and in accordance with the profile of the educational institution. In order to implement virtual learning environment, it is necessary to take into account individual characteristics of education applicants in the organization of their learning activities, which will allow students to build their own educational trajectory, taking into account the individual learning rate, the depth of mastering the content of training program and educational needs. The efficiency of such training will significantly increase with the use of digital and information and communication

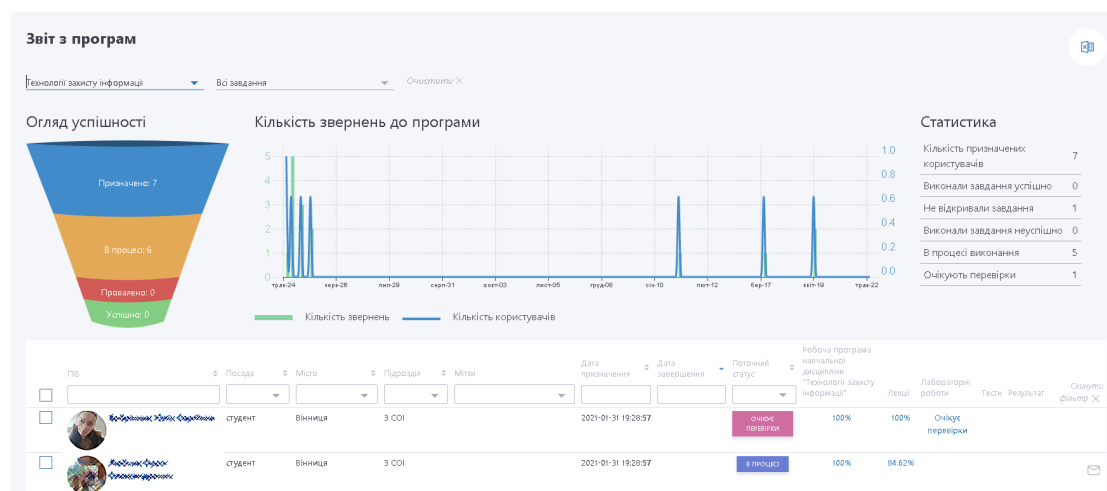


Figure 6: Program report in Collaborator.

technologies, which will provide significant opportunities for expanding the individualization and differentiation of the training process in accordance with the cognitive characteristics of the education applicants.

The ability of such a virtual learning environment to modify, change its parameters as required by the participants of the educational process contributes to the continuity of virtual learning, disclosure and identification of individual creative abilities of students. The implementation of interactive forms and methods of learning, especially when organizing independent learning activity in a virtual environment, is a significant factor in increasing motivation for learning and cognitive activities, raising the level of emotional perception of the new material. In the virtual environment a set of conditions is realized, contributing to the process of active interaction between instructors and students through the orientation on the implementation of various types of independent work, including information and educational, experimental and research, scientific and practical activities on the basis of modern digital technology.

Consequently, taking into account the described objectives, functions, advantages and disadvantages of the educational site of the teacher and learning management system, we can conclude that the described capabilities fully provide the implementation of a comprehensive implementation of virtual learning environment in the learning process of higher education applicants using modern digital technology.

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