Synergy of virtual learning environments in the context of implementing the principles of remote learning for higher education applicants: economic aspect

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Abstract

The article reveals the peculiarities of complex implementation of educational websites of teachers and learning management system in a remote learning environment, analyzes the economic aspect of their use: the continuity of training in extreme conditions, the ability of participants in the educational process to be in a safe place, and saving university resources. It is the synergistic combination of these components of the virtual environment improves the educational level of higher education applicants, develops their creative potential, ensures the effectiveness of learning activities on the use of modern digital technology. 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. Pedagogically balanced use of educational websites and learning management systems in remote education conditions by teachers in their professional activities contributes to providing students with individualized learning pace, differentiated complication of educational 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 educational environment, it is necessary to take into account individual characteristics of applicants for education in the organization of their learning activities, which allows students to build their own educational trajectory, taking into account individual learning rate, the depth of assimilation of the content of the training program and educational needs. The efficiency of such training will significantly improve with the integrated use and interaction of digital and information and communication technologies, which provides opportunities for expanding the individualization and differentiation of the educational process in accordance with the cognitive characteristics of applicants for education.

Keywords

virtual learning environment, teacher's website, learning management systems, test control in learning management system

1. Introduction

The development of digital technologies [1], their introduction into the educational process of higher education institutions [2], the transition to the remote learning form due to the COVID-19 pandemic and martial law in Ukraine, the appearance of various gadgets for students, the requirements of society to improve the quality of educational services [3] – all these processes have caused the pedagogical

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community to put the question of updating approaches to the formation of the learning environment [4, 5] through the introduction of virtual learning environment in higher education.

The creation of virtual learning environments has another rather important aspect for both individuals and society as a whole: economic and security. We pay attention to: saving on resources; creation of educational websites as a reusable resource, the content of which is more convenient to modify in accordance with specialties and educational programs; ensuring mobility; guaranteeing a safe place to be, which affects the country's economy; the need to integrate education into the European space (in particular, creating terminology dictionaries, harmonizing the spelling of mathematical terms).

The effectiveness of distance education 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. At the same time, the creation of virtual learning environments increases the popularity of distance education, which in modern realities is the most flexible and accessible for students. The main advantages of distance education from the point of view of the student are: the ability to study at a convenient time (subject to asynchronous learning); attend classes from any location (reduced transportation and accommodation costs); combine undergraduate studies with professional activities; quick feedback.

To organize distance learning, a teacher creates an author's virtual learning environment in which he or she posts relevant educational material (lectures, practical, laboratory, presentations with multimedia support) with the possibility of its quick updating. Students have the opportunity to reuse the proposed educational content and at the same time observe progressive trends in the development of a particular discipline.

2. Literature review

The current conditions of our country dictate an urgent need for various specialists, including educators and scientists. This was reported by the newspaper Ekonomichna Pravda on June 9, 2023 [6] and the website work.ua. They note that the growth in the number of job offers is faster than expected, and estimate this by comparing linear trends in the number of vacancies, dividing them into two periods: before and after February 24, 2022 (figure 1). The study showed that demand for doctors, accountants, farmers, educators, scientists, salespeople, buyers, insurers, lawyers, and top managers is recovering the fastest. Their recovery curves are even better than they were in 2021, for example.

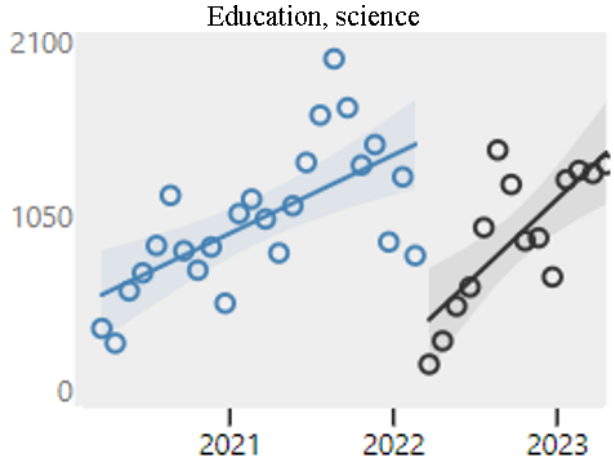

Figure 1: Recovery of demand for professions in 2021-2023 – education, science [6].

Aljumaiah and Kotb [7], Barcia and Gonzalez [8], Kosovets et al. [9], Trius et al. [10], Skurativska and Popadiuk [11], Falshtinska [12], Krasilnik [13] investigated the problem of virtual learning environment application as a necessary component of the educational process in higher education. Osadcha et al. [14], Husak and Radzihovska [15], Hendrickson [16], Verstege et al. [17], Nechypurenko et al. [18, 19],

Tsvetkova et al. [20] analyzed the features of teaching natural and mathematical subjects in higher education institutions using virtual learning environment facilities.

Verstege et al. [17] 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 [17]. Such projects allow for simulation modeling of processes and phenomena in a virtual environment, as well as virtual experiments and research. This is especially true in the context of blended or distance learning, when access to university laboratories is limited or impossible, and learning must continue, as the training of modern specialists is essential for the recovery and development of many sectors of the economy.

The results of the study by Theelen et al. [21] suggest that virtual internships can be useful for teacher education. The authors define virtual internships in teacher education as online environments in which teachers think and act as teachers through assignments based on authentic classroom contexts. It is proposed to make such virtual internships part of blended courses in terms of personalization, authenticity and collaboration, where blended learning combines online materials with personal learning and support.

Thus, on the one hand, teachers can immerse themselves in virtual educational content as learners and evaluate the advantages and disadvantages of online learning. On the other hand, such initiatives allow saving budget funds for related expenses related to the cost of travel or accommodation of course participants and accumulating funds for other items of expenditure related to ensuring a quality educational process in educational institutions.

Purnomo et al. [22] analyses the findings of the World Economic Forum, which point to the need for technological knowledge. This includes developing students' competencies in digital risk and security management and understanding the responsibilities of responsible technology developers and consumers. The article also describes the change management framework for the integration of a virtual learning environment and its impact on the transformation of the digital school culture.

Moreno-Barahona et al. [23] consider quantitative data analysis for virtual learning environments in terms of conceptual integration and empirical validation of a unified taxonomy. The authors of the article conducted a detailed review of existing research on measuring virtual communities of practice in various disciplines during 1990-2023.

We see prospects for further research in the area of integrating online communities into virtual educational environments.

Ghanbarzadeh and Ghapanchi [24] prove that Three-Dimensional Virtual Worlds (3DVW) have a significant promise for the development of teaching and learning environments. The researchers identified 26 factors to the acceptance of 3DVW in higher education. Those factors are then classified into 12 categories based on their definition and similarities: infrastructure, attractiveness, cost efficiency, self-efficacy, sense of presence, virtual environment, ease of use, usefulness, accessibility, enjoyment, convenience, and interaction. Twenty-one out of the 26 impact factors the user acceptance of 3DVW positively, and five impact factors it negatively. Antecedents with a positive effect: User friendliness, Perceived ease of use, Perceived usefulness, Ease of access, Access flexibility, Visual attractiveness, 3DVW reliability, Data security, Communication flexibility, Perceived enjoyment, Perceived playfulness, Cost efficiency, Time efficiency, Perceived schedule flexibility, Perceived convenience, Multi-functionality, Customisability, Interactive learning material, Technology savviness, Sense of presence and Self-confidence. Antecedents with a negative effect: Hardware dependency, Internet dependency, Perceived distraction, Social isolation and Interaction difficulty.

The goal of the article. To reveal the peculiarities of the synergy of virtual learning environments in the context of the implementation the principles of distance learning for higher education students and

the economic aspect of the integrated implementation of teachers' educational websites and learning management systems for organizing distance learning for students.

3. Research methods

The authors of the article conducted a monitoring study to assess the functionality of virtual educational environments through the eyes of students using data collection methods: documentation analysis, surveys, and observations (table 1, figure 2).

Table 1
Students' assessment of the functionality of virtual educational environments.

Virtual learning environments	LMS "Collaborator"	Google Classroom
Evaluation of the functionality of virtual educational environments through the eyes of students	Empirical data (number of students)	
High	11 (32 %)	5 (15 %)
Sufficient	19 (56 %)	16 (47 %)
Satisfactory	4 (12 %)	13 (38 %)

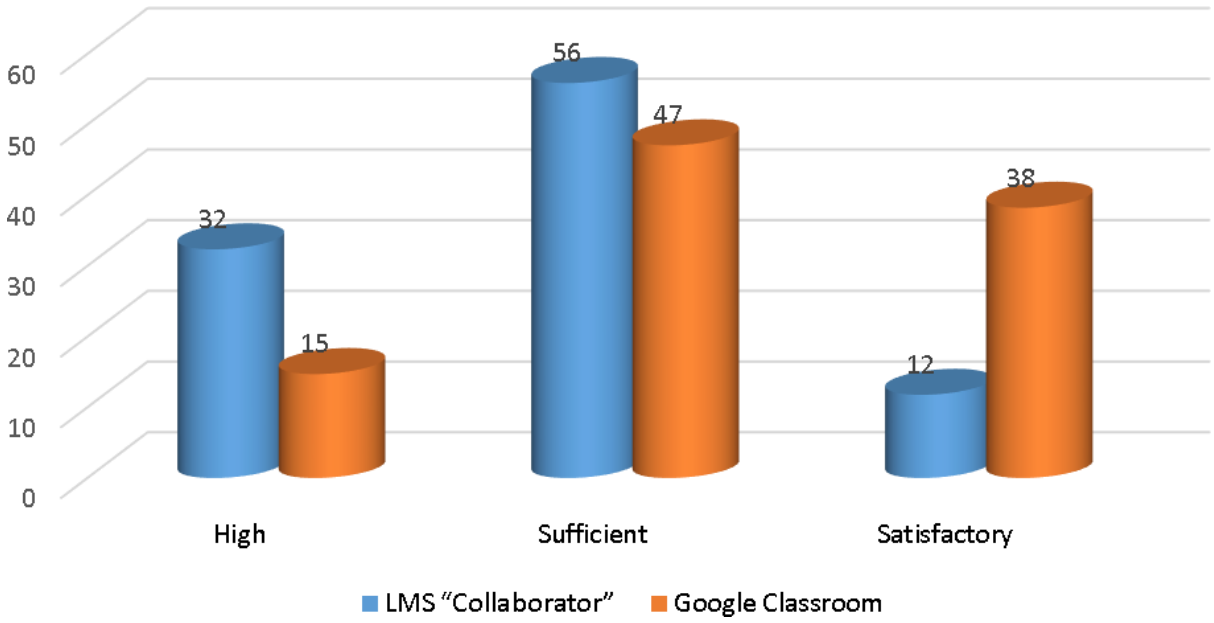

Figure 2: Assessment of the functionality of virtual learning environments by students (in percent).

In order to verify the results of pedagogical research, the Wilcoxon-Mann-Whitney U test was used [25]. The samples of students were taken among students of the Faculty of Mathematics, Physics and Computer Sciences of Vinnytsia Mykhailo Kotsiubynsky State Pedagogical University (Vinnytsia, Ukraine). The algorithm for implementing this criterion assumes that all X-elements of the first and Y-elements of the second sample are combined. The combined sample $x_1, x_2, \ldots, x_{n1}, y_1, y_2, \ldots, y_{n2}$ (n_1 and n_2 – sample sizes) are ordered in ascending order. The elements of the first sample $x_1, x_2, \ldots, x_{n1}$ take places in the general variation series with sample numbers $R_1, R_2, \ldots, R_{n1}$, that is, they have ranks $R_1, R_2, \ldots, R_{n1}$.Then the sum of the ranks of the elements of the first sample is the Wilcoxon statistic T_x:

$$T_x = R_1 + R_2 + \ldots + R_{n1}.$$

The Mann-Whitney U statistic is defined by the formula

$$U = (n_1 + n_2) + \frac{n_x(n_{x+1})}{2} - T_x.$$

Since T_x and U are linearly related, it is not about two tests – Wilcoxon and Mann-Whitney, but about one test – Wilcoxon-Mann-Whitney. The smaller the empirical value of the U_{emp} criterion, the more likely it is that the differences in indicators are reliable. For the U-criterion, the null hypothesis H_0 is accepted under the condition U_{emp}>U_{kr}.

Students actively participated in the survey, which aimed to find out whether the use of virtual educational environments is a popular resource in the educational services market (table 2).

Table 2
Survey of students on the use of virtual educational environments.

Questions / answer options	Yes	No	I can't estimate
Does the use of virtual learning environments reduce the costs of transportation and accommodation associated with studying at a higher education institution? (figure 3)	64	6	5
Does the use of virtual learning environments facilitate effective planning of time and place of study? (figure 4)	56	10	9
Does the use of virtual learning environments help to reduce the cost of learning materials (e.g., manuals, textbooks)? (figure 5)	57	9	9
Has the quality of learning improved as a result of using virtual learning environments? (figure 6)	33	14	28
Is it convenient for you to combine online learning with your professional activities? (figure 7)	53	10	12

The visual interpretation of the study results is presented in the form of figures 3-7.

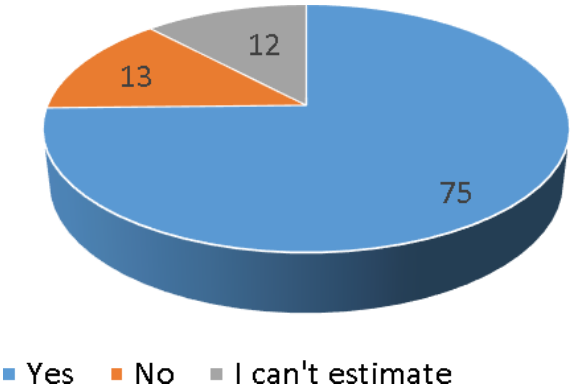

Figure 3: Does the use of virtual learning environments reduce the costs of transportation and accommodation associated with studying at a higher education institution? (in percent).

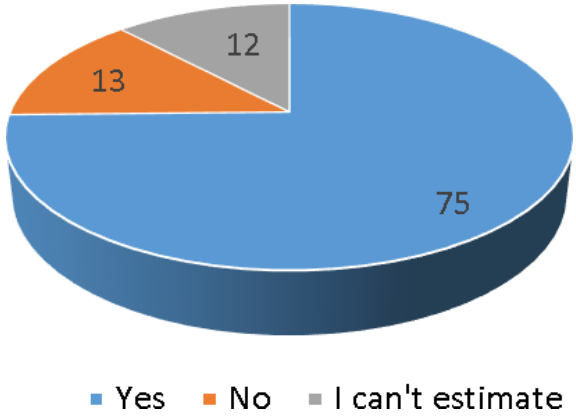

Figure 4: Does the use of virtual learning environments facilitate effective planning of time and place of study? (in percent).

Students also had the opportunity to answer other questions.

- Which media do you prefer – virtual learning environments / paper textbooks and manuals / does not matter. The results are shown in figure 8.
- Which, in your opinion, elements of the educational process will play an important role in the future? (figure 9)

The results of the study show that the synergy of virtual educational environments in the context of implementing the principles of distance learning for higher education students is relevant and has an economic effect from the integrated implementation of teachers' educational websites and learning management systems for organizing distance learning for students.

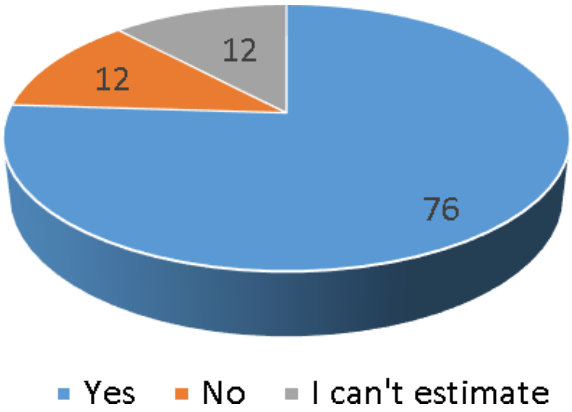

Figure 5: Does the use of virtual learning environments help to reduce the cost of learning materials (e.g., manuals, textbooks)? (in percent).

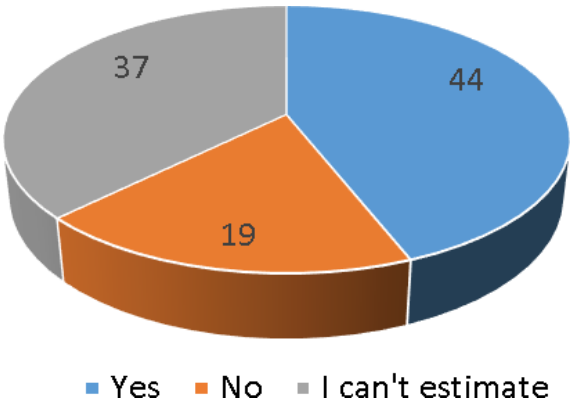

Figure 6: Has the quality of learning improved as a result of using virtual learning environments? (in percent).

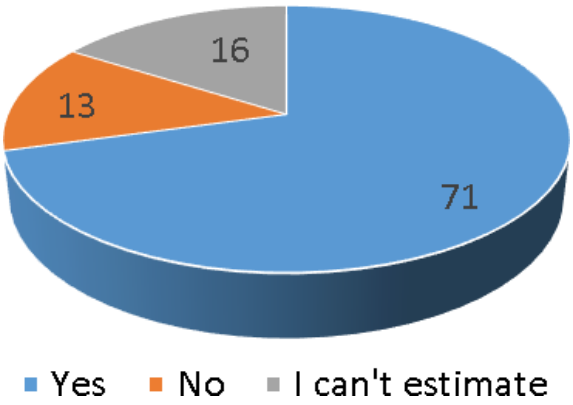

Figure 7: Is it convenient for you to combine online learning with your professional activities (in percent).

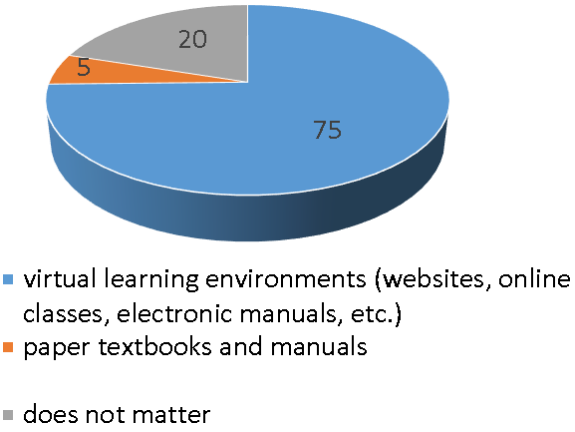

Figure 8: What media do students prefer to use? (in percent).

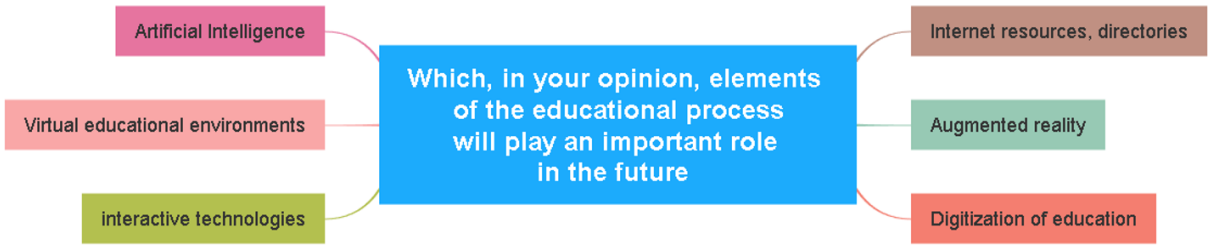

Figure 9: The results of the student survey on the elements of the educational process will play an important role in the future.

4. Research results and discussion

With the development of virtual reality technologies in education, 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.

Smulson [26] 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.

Skurativska and Popadiuk [11] 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. Zhuk and Sirenko [27] 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.

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 educational web site https://kovtonyuk.com/ was created to implement the information and communication technologies in the educational process and as a tool of network interaction of all participants in the educational 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 or site → 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.

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. On the teacher's website https://kovtonyuk.com/, 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.

The electronic textbook creates the preconditions for overcoming physical, sensory and cognitive barriers to inclusive education for students with special educational needs. For example, for blind and dyslexic students, the e-textbook allows them to convert learning content into accessible electronic formats.

The e-textbook presents the material in different forms: along with the text, there are illustrations, video clips, dynamic demonstrations and practical tasks, which are voiced by an on-screen speaker. This allows students with special educational needs to perceive the learning content through different senses, which contributes to better learning.

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.

Virtual learning environments are closely related to the new paradigm of education, which is based on the transition to digital educational technologies to ensure inclusive education for students with special educational needs. Kovtoniuk et al. [28], Soia et al. [29] analyses the development of inclusion and proposes building an effective system of inclusive education in Ukraine, which is possible through the interaction of various factors, primarily strengthening education funding, improving its regulatory and legal support, and using modern digital educational technologies in the process of teaching higher education students.

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.

Dobre [30] write that LMSs are web-based learning systems that allow instructors to create, manage and communicate course content. LMSs play an important role in improving and supporting remote and mixed teaching and learning in today's digital environment. LMSs can provide interactive tools such as blogs, wikis, chat rooms, and discussion platforms that allow virtual learning environments to develop constructivist approaches to learning.

Mershad and Wakim [31] 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.

Osman [32] 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, ILIAS, 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.

Vinnytsia Mykhailo Kotsiubinskyi 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. 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.

Kosovets et al. [33] 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.

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 10).

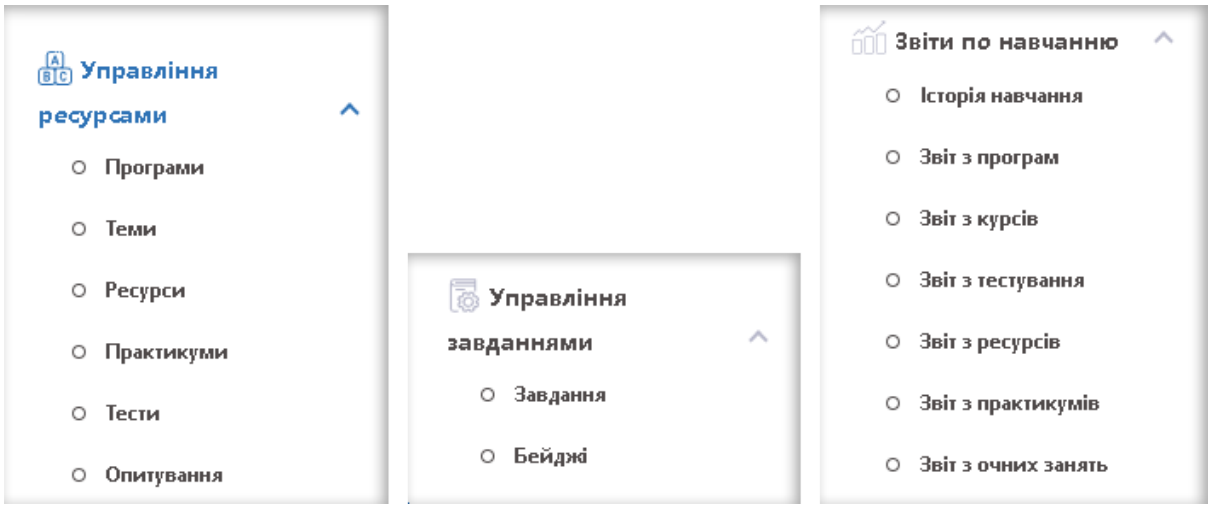

Figure 10: "Tutor" mode.

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.

For the teacher, LMS Collaborator provides a convenient tool to record and control students' knowledge, allowing them to set deadlines for test assignments and regulate the number of retakes, generates an automated system for rating students' independent work in the form of a test control report. The function of controlling the knowledge of applicants in the system can be implemented by using the Test command in the Resource Management block.

There are seven question types available to the teacher to create a test question: single, multiple, free response, compose, classify, match, and select an area in the image (figure 11).

From several tests you can create a complex test, allowing you to check the knowledge of the student on several topics at the same time. At the end of the test a summary result is generated for all topics and separately for each test passed.

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.

The Learning Management System allows you to integrate the instructor's educational site into

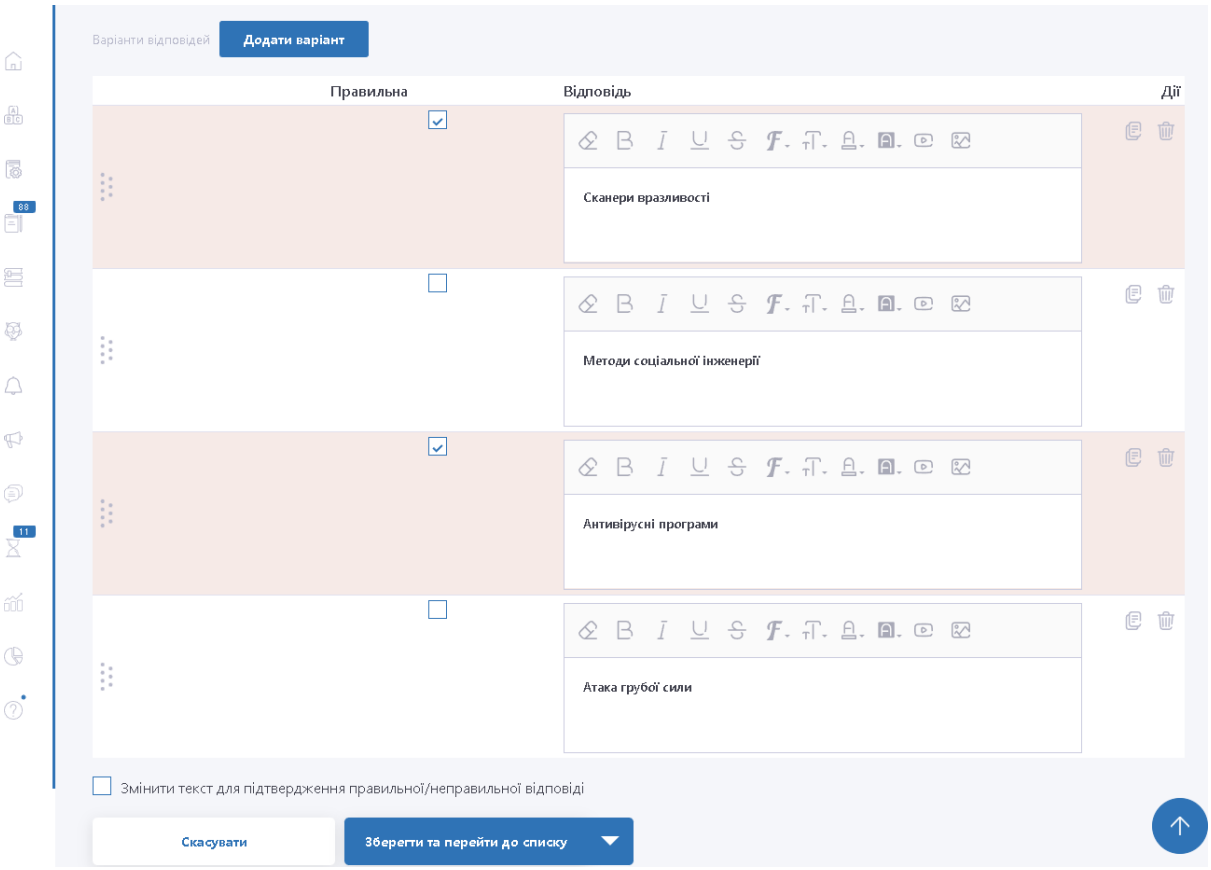

Figure 11: Types of questions to create a test question (multiple and composition).

the program and learning resources to share learning materials. The integrated use and expedient combination of educational sites and learning management systems provide faculty with a synergistic combination and interaction of digital tools for organizing and conducting remote learning for higher education applicants.

The developers of the educational platform LMS Collaborator have worked to adapt learning materials for students with special educational needs. It is possible to add subtitles to videos and create audio versions of text materials. The teachers also analysed all the materials for readability using clear fonts and colour schemes recommended for people with dyslexia and other peculiarities of perception of educational content.

Using the methods of mathematical statistics, we will compare the effectiveness and functionality of the LMS "Collaborator" and Google Classroom virtual educational environments. To test the hypothesis about the homogeneity of these educational platforms, we will use the Wilcoxon-Mann-Whitney U test for two independent samples.

To conduct the pedagogical research, the criteria that characterise the educational environment as virtual and meet all the requirements for such an environment were selected, namely: 1) immersiveness of the learning environment is a criterion for determining the level of student immersion in the learning environment when interacting with platforms; 2) interactivity assesses the level of interaction between participants in the educational process on both platforms, in particular, how effectively the platforms promote active interaction between students and teachers, provide an opportunity for data exchange and cooperation; 3) the level of dynamism of platforms, i.e. their ability to change and adapt the content, structure and settings of the learning environment; 4) sense of presence assesses the ability of the platform to create a sense of involvement, to what extent students feel present in the sense that they are in the same space with other participants, despite their remoteness; 5) continuity, i.e. the ability of virtual educational environments to ensure the continuity of the learning process, to what extent

students can easily and continuously access learning materials and tasks; 6) temporality and causality: the participants of the experiment will analyze how clearly and logically the information presented on both platforms is presented; 7) analysis of cause and effect: students will analyze how the platforms help to understand the dependencies between actions, events and consequences, which contributes to a better understanding of the topics and concepts presented in the virtual educational environment.

Null hypothesis H_0: the differences in the indicators of the characteristic are not statistically significant, namely, there are no differences between the functional capabilities of the educational platforms – the virtual educational environments LMS "Collaborator" and Google Classroom have sufficient functionality for distance learning of education seekers.

Alternative hypothesis H_1: the differences in the indicators of the characteristic are statistically significant, that is, it is about the significance of the differences regarding the functionality of the specified virtual educational environments – LMS "Collaborator" has more functionality in providing adaptive learning for students.

Table 3
Calculations according to the Wilcoxon-Mann-Whitney U test.

Virtual educational environments	LMS "Collaborator"	Google Classroom
Sample sizes n_1, n_2	34	34
Sums of ranks T_1 and T_2 for two samples	1366.5	979.5
Volume n_x of the sample with a larger sum of ranks	34	
T_x the largest of the two (T_1 and T_2) rank sums	1366.5	
U_{emp}=	384.5	
$U_{0.005}$=	443 [25]	

Let's build an axis of significance (figure 12).

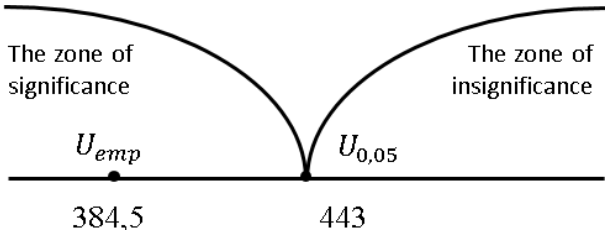

Figure 12: Axis of significance.

Since $U_{emp} < U_{0.005}$ (384.5 < 443), the null hypothesis H_0 is rejected at the 0.05 level. Therefore, it can be stated that the assumption about the significance of the differences regarding the functionality of the specified virtual educational environments is statistically significant.

Therefore, LMS "Collaborator" meets all the properties of virtual educational systems, while Google Classroom has slightly lower indicators, which confirms that learning management systems are more suitable for implementing the educational process in LMS "Collaborator".

Based on our research, we can highlight the main advantages of virtual learning environments in teaching higher education students: a more flexible learning process; the ability of students to actively communicate and collaborate both synchronously and asynchronously; students benefit from a diverse amount of educational content and its integrity; the formation of students' psychological states, which manifests itself through purposeful and self-motivated learning, the ability to self-education. Teachers act as mentors, trainers, coaches, tutors and facilitators with the help of digital technologies. Learning becomes more effective due to the construction of an individual educational trajectory at any pace, which leads to exceptional results compared to face-to-face classes due to flexible access to educational resources.

Potential risks and limitations of virtual learning environments include: delays in feedback between student and teacher, negative impact on psychological well-being, significant equipment costs, health

risks due to prolonged screen time and lack of physical activity.This conclusion is consistent with research.

The conditions of martial law in Ukraine make negative adjustments to the full use of virtual learning environments. Unstable internet connections, constant threats from air raids and frequent power outages create additional difficulties for students and teachers.

5. Conclusions and recommendations

The dynamics of the modern world imposes new requirements for teachers of educational institutions to prepare responsible individuals capable of adapting to modern society for adult life. Hence, one of the main goals 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 the conditions of remote learning, 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.

In this work, we interpret the concept of "virtual learning environment" 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 technology, taking into account individual educational characteristics of the student. The key properties of virtual learning environments include immersive learning environment; interactivity (active user interaction with the artificial environment); dynamism (rapid change of events); imagery; sense of presence (experiencing sensations identical to reality); continuity (possibility of infinite representation); temporality and causality (rotational time; activation of cause and effect 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 are designed by means of websites and modern learning management systems. These tools are web-based applications that allow for the administration of learning content in remote learning, provide a convenient way to manage learning and allow for a number of tasks that previously required a large number of different tools.

The use of virtual learning environments also has a significant economic and security effect for both the university and the student: the ability to study at a convenient time (subject to asynchronous learning); attend classes from anywhere (reduced transportation and accommodation costs); the ability to stay in safe places during studies; combine undergraduate studies with professional activities; and quick feedback.

The authors' monitoring study of the effectiveness of virtual learning environments and confirmed by the Wilcoxon-Mann-Whitney U-test showed that the use of virtual learning environments also has a significant economic and security effect for both the university and the student: the ability to study at a convenient time (in case of asynchronous learning) (75%); attend classes from any location (reducing transport and accommodation costs) (75%); the ability to stay in safe places during study; combine learning and work. Using the methods of mathematical statistics, the authors have carried out a comparative analysis of the effectiveness and functionality of some virtual educational environments.

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