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USE OF INNOVATIVE DIGITAL EDUCATION TECHNOLOGIES IN HIGHER SCHOOL DURING DISTANCE LEARNING

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Abstract. The rapid growth of the new educational technologies and the ability to work with them under the conditions of innovative technologies require a professional approach and a detailed analysis of the educational process. Modernization of higher education is inevitable. The authors of the article examine the prerequisites and trends of global digitalization of education, discuss various aspects of digitalization of higher education as an organizational and pedagogical condition to enhance the quality of education. The article highlights issues how to improve the digital competence of specialists who use innovative training technologies, and to raise their qualifications under modern conditions. Digital competencies of subjects of the educational process have been formed using innovative teaching methods. The use of digital tools at higher education institutions has been studied in the context of distance learning, and the ways to solve them. There are considered the problems of spreading the digital technologies, and widespread use of the information communication (digital) technologies in education. There are identified the main directions of development of the digital educational technologies, which will help expand the capabilities of the traditional learning models, based on the creation of a unified digital educational space. This is the main purpose of this article. The basis of the research is theoretical (comparative analysis of scientific, methodological and pedagogical literature) and empirical (observation, analysis and generalization of pedagogical learning experience) methods. During the pedagogical experiment there were identified the advantages and challenges for the teachers of using the digital technologies in the educational process of higher education in Ukraine. It has been confirmed that the digitalization of the educational environment transforms the motivational value sphere, expanding the boundaries of possibilities to communicate.

Keywords: innovative technologies, digital education, educational process, distance learning.

Introduction

Formulation of the problem. In the global information space, there is a change in traditional educational paradigms, forms of organization of the educational process, and their transformation into a digital format. The shift to online teaching as a result of the COVID-19 pandemic and geopolitical events, particularly the Russian war, has become a pivotal point in the history of higher education. This process was marked by a revolutionary impact of digital technologies upon learning, and it forced educational institutions to quickly adapt to the new realities. However, the technological prospects are not unlimited. Without adequate infrastructure and technical support there may arise problems with access to education. It is also important to consider that not all higher education applicants have the same level of access to technology, which can lead to social inequality in the educational process. The rapid expansion of digital technologies also requires significant efforts from the higher education institutions to train teachers and create relevant curricula. Further radical changes could include the development of virtual reality, enhanced learning and other innovative approaches that will improve the quality of education and prepare the job seekers for the challenges of the modern world. The importance of these skills in the modern society has become apparent, and institutions around the world have begun to implement relevant programs and research. This is what determined the topicality of the present study.

Analysis of the current research. The issues of digitalization of education and distance learning have been at the centre of scientific discussions over the past decades. A large number of scientific studies concern the problem of positive and negative consequences of introducing digital technologies into the educational process.

The issues of scientific and methodological support for the digitalization of education in Ukraine have been studied by: Bykov V. Yu. [1], Dubasenyuk O. A. [2], Kremen V. G., Ilyin V. V., Proleev S. V. [3], Saukh P. Yu. [4] et al. The researchers point to a number of factors that determine the quality of online teaching and learning, highlighting the problems that teachers face and may face when trying to make distance learning as effective as possible.

Most researchers explain the necessity of using an innovative approach in education to the general processes of society, digitization and globalization of everyday spheres of human life [3; 4].

Digitization of the educational process makes learning mobile, differentiated, individual. The integration of digital technologies into the educational activity allows the teacher to increase the social mobility of the student, adapt him to the external information environment, transfer him to the mode of self-development, turning him from an object of pedagogical influence into a full-fledged subject of the educational process [1].

O. Dubasenyuk connects innovations in the educational process with the search for new ideas to solve organizational problems and the modernization of the educational process, and the introduction of innovative technologies occurs thanks to a pedagogical experiment or the method of pilot implementation [2, p. 15]. It should be noted that the continued existence of an innovation depends on how successfully it functions and moves to the stage of stable development.

Digitalization in the field of education attracts the attention of foreign scientists: Bilotta E. [5], Camilleri M., Camilleri A. [6], Costley J., Lange C. [7], Emmanuel G., Sife A. [8]. Digital technologies have also found application in the research work by Bulgakov V. [9-11], as well as Fauzi M. [12], Ferri F., Grifoni P., Guzzo T. [13], Kostopoulos G., Kotsiantis S. [14], Qureshi M., Khan N., Raza H., Imran A., Ismail F. [15], Xie X., Zang Z., Ponzoa J. [16]. In the studies of foreign scientists, attempts are being made to highlight the decisive characteristics of the emerging digitalization and digital culture. The advantages of using digital technologies in the education system are pointed out, allowing to meet the demands of the modern labour market.

The works [8; 14] describe the problems of teaching students during distance learning. Integration of technology into education provides the students with intriguing learning experiences, allowing them to remain more interested in the subject. The use of projectors, computers and other modern technological equipment in the lecture room can make learning fun and interesting for students. The students' learning may be more dynamic and entertaining when there are provided tasks that include technological resources, oral presentations, and group participation. Participation can go beyond verbal communication [5; 15].

The COVID-19 pandemic had a deep impact upon online learning. With the closure of universities, distance learning has become a necessity for many students and teachers, and the digital technologies have played a decisive role in ensuring this transition [13; 17; 18].

According to Camilleri M., Camilleri A.: "Digital learning is a great way to better use resources, promote sustainable development, and expand the extent and impact upon the students and teachers" [6].

The article [2] describes application of digital technologies in education. There is discussed the necessity to implement digital technologies into education and their application in the educational process. The main problems of digital technologies are discussed, and the future of digital technologies in education is described.

According to Costley J., Lange C., digital learning may have a greater impact upon the students' success than traditional classroom teaching [7]. The research by Fauzi M.A. showed that the advanced technologies have a positive effect upon the adoption of digital learning [12].

Although the scientific and methodological works carry out a broad analysis of this issue, they do not indicate solutions, that is, it is advisable to develop such teaching materials that would specify the system of methods and means of teaching a particular discipline in order to form and develop the professional qualities of applicants and help eliminate the problem. The development of specific methodological materials that not only analyse the problem but also offer solutions, is an important step in improving the quality of education.

Consideration of the main directions of development of the digital educational technologies, the development of content of proprietary integrated courses in order to provide theoretical and practical assistance to the teaching staff in the formation of digital competence, implementation of the competency-based approach, and its practical use in the distance education system – this is the basic purpose of our investigation.

To evaluate the developed methodology, the following methods were used: questionnaires, testing, conversations (with the higher education applicants, the teachers of fundamental and professional disciplines), scientific observation.

Materials and methods

Research methodology. During the past four years domestic education has been operating under the emergency and dangerous conditions. Since 2020 higher education in Ukraine has been functioning under quarantine restrictions and military operations of the Russian Federation when an important task was to preserve the health and life of the participants of the educational process and introduction of distance learning for this purpose.

In this research the results of the pedagogical experiment were assessed, based on a comparison of the performance of the first-year applicants at the engineering and technical faculties, in particular the Higher Education Institution “Podolsk State University” in Ukraine. The applicants in the control groups were trained according to the usual methods. In the process of training the experimental groups were introduced with developed methodological approaches to the organization of distance learning in physics, which consisted of using not only the program software and methodological software but also a course material, containing a professional focus on training. Knowledge monitoring was carried out during the reports in the Google Classroom, during blitz testing in the Classtime service, during the data protection of the training experiment and during thematic testing on the website <http://pdatu.net.ua>.

119 applicants from the Faculty of Engineering and Technology took part in the organization of the pedagogical experiment, among which 57 applicants were included in the control groups, and 62 applicants were in the experimental groups.

When organizing distance learning during the quarantine period and during martial law at the National University of Bioresources and Environmental Management of Ukraine, at the Institution of Higher Education “Podolsk State University” and the Latvia University of Life Sciences and Technologies, the teaching of academic disciplines for training of agricultural engineers was carried out in lectures, practical and laboratory classes. The classes were conducted in synchronous and asynchronous modes, using information and communication (digital) technologies, including virtual educational platforms: Moodle, Classroom, ZOOM web conferences, Google Meet, Viber, Messenger, etc. The choice of such communication channels made it possible to expediently organize individual and group work of the education seekers, transmit text messages, photo and video materials, and organize video communications.

By means of the ZOOM platform, the lecture material was presented using professionally directed material; laboratory and practical classes were conducted, which were recorded and then presented in electronic courses. This made it possible for the students who were not present in the online classes to become familiar with the topic by viewing the discussion in the recordings (Fig. 1). In addition, virtual interactive whiteboards were used during the classes, for example, iDroo, Padlet.

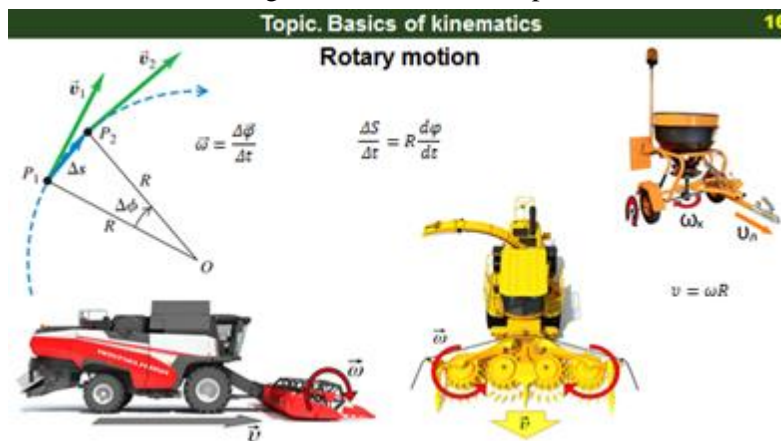


Fig. 1. Example of presentation of the lecture material, using professionally directed material

For a more complete and convenient acquisition of the material in the practical classes, using the Moodle platform, an electronic textbook – “Physics” is provided, where for each module in the academic discipline there is ensured concise theoretical material, specific examples of problem solving are offered, and tasks are posted for individual execution. There are also included general recommendations by the stages of solution of the problem for performing independent work (Fig. 2).

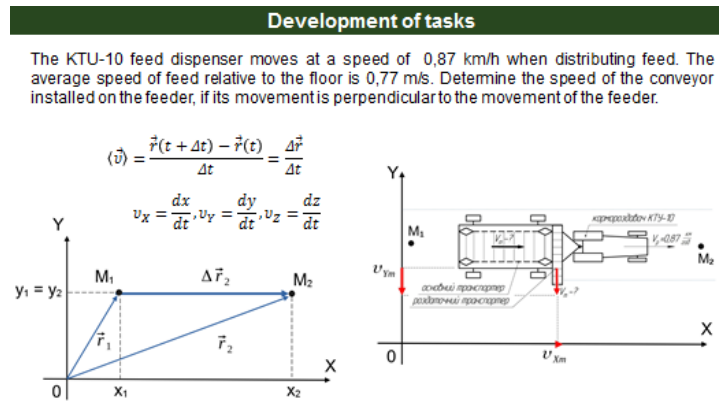


Fig. 2. Solution of problems, using professionally directed material

A very important stage in the formation of knowledge and cognitive activity is the shift of the students from theoretical learning to practical application of knowledge when performing the laboratory work (Fig. 3).

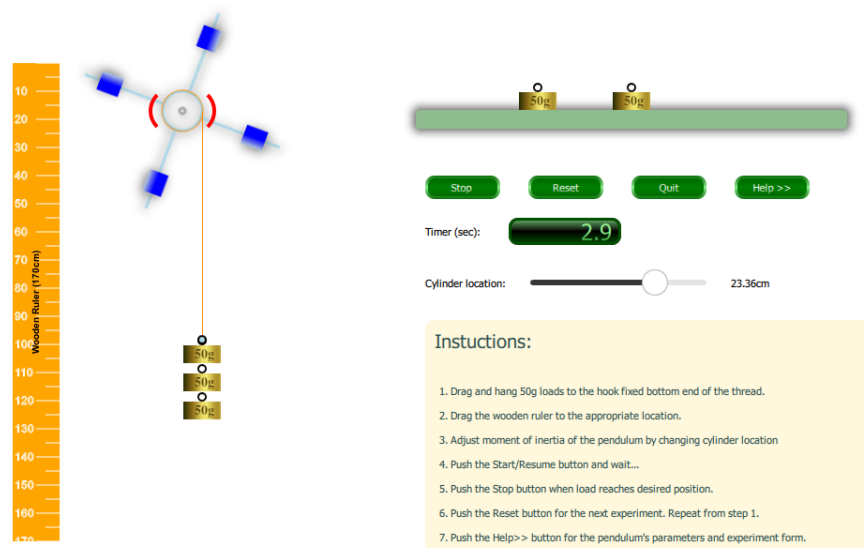


Fig. 3. Virtual laboratory work “Determination of the moment of inertia of a body, using an Oberbeck pendulum”

When performing the laboratory work, the students acquire skills in using physical instruments and independent experimentation; they deepen and practically consolidate theoretical material, and receive confirmation of physical laws in practice.

Results and discussion

To establish the efficiency of methodological approaches to organizing distance learning in physics at the Higher Education Institution “Podolsk State University”, the following criteria were used: the activity-based, efficiency-based and the reflexivity-based approach. The activity-based criterion presumed that the applicants could use theoretical knowledge when solving problems, performing laboratory work and independently studying the physics material. The efficiency-based criterion tested the applicants’ ability to evaluate their own performance. The reflexivity-based criterion determined the applicants’ ability to analyse their own activities and awareness of the need for timely reporting on the work done.

The indicator of the reflexivity-based criterion of applicants’ ability to realize the need to timely report on the work performed was determined in the reporting process. Based on the results of reporting of the applicants in the control (reference) and the experimental groups, they were divided into four groups, which corresponded to the levels of the assessed efficiency of the methodological system for organizing distance learning in physics (Table 1).

The comparison of the distributions of applicants in the control (reference) and experimental groups showed that in the groups of applicants, trained using the traditional method, there were almost no positive changes in such an indicator as the level of awareness of the need to timely report on the completed work.

Table 1

Distribution of applicants by the level of the reflexivity-based criterion

Levels	Control (Reference) group		Experimental group	
Initial	36	64%	23	37%
Medium	16	27%	24	39%
Sufficient	4	8%	12	19%
High	1	1%	3	5%

In a similar way we calculated the indicators of the activity-based and the efficiency-based criteria. The results of the distribution of applicants by the levels of formation of indicators of the activity-based and the efficiency-based criteria are given in Tables 2, 3. Their analysis shows that in the experimental groups there were positive changes in all indicators.

Table 2

Distribution of applicants by the level of the development of the activity-based criterion indicators

Indicators	Groups	Levels of formation of indicators of the activity-based criterion							
		Initial		Medium		Sufficient		High	
		Num. of stud.	%	Num. of stud.	%	Num. of stud.	%	Num. of stud.	%
Applicants' ability to apply theoretical knowledge when solving problems	C(R)	37	66	15	26	4	7	1	1
	E	23	37	24	39	12	19	3	5
Applicants' ability to carry out experimental research	C(R)	22	39	22	39	7	12	6	10
	E	9	16	27	45	17	27	9	12
Applicants' ability to work through the physics material independently	C(R)	22	39	27	47	5	9	3	5
	E	16	26	22	36	17	27	7	11

Thus, the results of the experimental work confirmed the efficiency of the chosen approach to the organization of distance learning in physics. It has been established that the developed methodological approaches and didactic tools contributed to the organization of distance learning in physics at the above-mentioned universities.

Table 3

Distribution of applicants in the control (reference) and the experimental groups according to the level of formation of the performance criterion indicator

Indicators	Groups	Levels of formation of indicators of the efficiency-based criterion							
		Initial		Medium		Sufficient		High	
		Num. of stud.	%	Num. of stud.	%	Num. of stud.	%	Num. of stud.	%
Applicants' ability to assess the level of their own achievements independently	C(R)	22	38	27	47	6	10	2	5
	E	10	16	29	46	16	26	7	11

The results of such targeted training were used to demonstrate to the students the research work presented in [6]. The presented mathematical research aroused high interest among the agricultural engineering students during distance learning, which confirms the innovative focus in training the future engineers and researchers.

Conclusions

1. The use of distance learning in the recent years indicates a fairly high, qualitative success of the higher education applicants. The use of the Google digital tools, the Moodle platform, and the Zoom service helps the applicants of higher education obtain knowledge in their chosen specialty in an accessible form and comfortable conditions, improve the individual work skills, maintain constant contact with the course leader, receive consultations, and participate in the scientific research work.
2. The results of the pedagogical experiment, which was conducted with the applicants from the Faculty of Engineering and Technology, showed positive changes according to the selected criteria, as evidenced by the applicants' higher indicators of the quality of knowledge in the experimental groups. So, the results of the pedagogical experiment proved the correctness of our initial hypothesis. Summing up, we state that the analysis of research and experimental work shows that the use of electronic educational resources in the process of professional training is of great importance and contributes to the improvement of the professional training of future agricultural engineers.
3. According to all the researched criteria (active, productive and reflective), we see that positive changes took place in the experimental groups. The results of the distribution of the students according to the level of formation of indicators of the activity criterion showed that for all the indicators presented, the high and sufficient level of skills increased by 4-10% compared to the results of traditional training. Positive dynamics are observed in the distribution of applicants according to the level of formation of performance criteria indicators. The ability of achievers to independently assess the level of their own achievements in the representatives of the experimental group compared to the results of the control group at a high level increased by 7%, while the low level in the experimental groups decreased by 22%.
4. The introduction of innovative digital education technologies into the educational process is currently generally accepted. The research conducted by us is the first to reflect the methods and strategies, aimed at developing the practical skills and abilities, necessary to perform specific tasks by the future specialists in the agrotechnical industry. The introduction of innovative digital education technologies into the educational process (using virtual educational platforms Moodle, Classroom, ZOOM web conferences, Google Meet), rich in interactive content, allowed us to effectively implement the principle of professional orientation in the study of the physics course. This contributed to the creation of a regime of "increased participation" of the students when studying lectures, the practical and laboratory work of the physics course.
5. Supplementing educational platforms for distance education with interactive content is not limited to the possibilities presented in the article and is a perspective topic for further research.

Author contributions

Conceptualization, I.S., O.B.; methodology, L.Z., I.S. and A.R.; software, L.Z.; validation, I.M. and A.R.; formal analysis, O.B. and L.Z.; investigation, O.B., I.S., L.Z. and I.M.; data curation, I.S., O.B. and L.Z.; writing – original draft preparation, O.B.; writing – review and editing, L.Z. and O.B.; visualization, I.M., A.R.; project administration, O.B.; funding acquisition, I.M. All authors have read and agreed to the published version of the manuscript.

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