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DIGITAL TECHNOLOGIES IMPLEMENTATION IN THE PROCESS OF TRAINING FUTURE TEACHERS

Abstract

The issue of using digital technologies in the process of training future teachers as one of the current trends of the present time was considered in the article. A theoretical analysis of the using digital technologies' problem in the educational process of Universities was carried out, a quantitative-qualitative analysis based on experimental research work was presented in the given research paper. In particular, a theoretical understanding of digital technologies used in the preparation of future teachers, examines their needs and opportunities in modern educational conditions was given in the article. The different tools and resources used to create and improve the digital learning environment in the educational space, development of thinking activities, forms of organization of learning, development of visualization, combining ideas, etc. were discussed by the authors. The study was focused on creating a system of intellectual tasks based on digital pedagogy that promotes critical and creative thinking skills. In the course of the experimental research, the method of questionnaire survey was conducted among the students of pedagogical educational programmes of E. A. Buketov Karaganda University and Bolashaq Academy via the social network "Google". The results of the survey were analyzed, conclusions were made and opportunities that may be achieved with the use of digital technology in the training of future teachers were summarized.

Keywords: digital technologies, digital learning, digital literacy, Internet, digital learning environment, distance learning, Internet resources, platforms, e-learning.

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БОЛАШАҚ ПЕДАГОГТАРДЫ ДАЯРЛАУ ПРОЦЕСІНДЕГІ ЦИФРЛЫҚ ТЕХНОЛОГИЯЛАРДЫҢ ЖҮЗЕГЕ АСЫРЫЛУЫ

Аңдатпа

Мақалада қазіргі кездегі өзекті векторлардың бірі ретінде болашақ педагогтарды даярлау процесінде цифрлық технологияларды пайдалану мәселесі қарастырылады. Осы зерттеу жұмысында жоғары оқу орындарының оқу процесінде цифрлық технологияларды пайдалану мәселесіне теориялық талдау жасалып, эксперименттік зерттеу жұмысы негізінде сандық–сапалық талдау берілген. Атап айтқанда, мақалада болашақ педагогтарды даярлау процесінде қолданылатын цифрлық технологиялар туралы теориялық түсінік берілген, олардың қазіргі білім беру жағдайындағы қажеттіліктері мен мүмкіндіктері қарастырылған. Мұнда білім беру кеңістігінде цифрлық оқыту ортасын құру және жақсарту үшін қолданылатын әртүрлі құралдар мен ресурстар туралы айтылады. Ойлау әрекеттерін, оқытуды ұйымдастыру формаларын дамыту, визуализацияны, идеяларды біріктіруді және т. б. дамыту. Зерттеу барысында сыни және шығармашылық ойлау дағдыларын қалыптастыруға ықпал ететін цифрлық педагогика негізінде зияткерлік міндеттер жүйесін құруға баса назар аударылған. Эксперименттік зерттеу барысында Е.А. Бөкетов атындағы *Қарағанды университеті* мен «Bolashaq» академиясының педагогикалық білім беру бағдарламаларының студенттері арасында сауалнама әдісі қолданылды. Сауалнама google әлеуметтік желісі арқылы жүргізілді. Сауалнама нәтижелері талданып, қорытындылар жасалды және болашақ педагогтарды даярлау процесінде цифрлық технологияларды қолдану арқылы қол жеткізуге болатын мүмкіндіктер қорытындыланды.

Түйін сөздер: цифрлық технологиялар, цифрлық оқыту, цифрлық сауаттылық, ғаламтор, цифрлық оқыту ортасы, қашықтықтан оқыту, ғаламтор–ресурстар, платформалар, электрондық оқыту.

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РЕАЛИЗАЦИЯ ЦИФРОВЫХ ТЕХНОЛОГИЙ В ПРОЦЕССЕ ПОДГОТОВКИ БУДУЩИХ ПЕДАГОГОВ

Аңдатпа

В статье рассматривается вопрос использования цифровых технологий в процессе подготовки будущих педагогов как одного из актуальных векторов современности. В данной исследовательской работе проведен теоретический анализ проблемы использования цифровых технологий в учебном процессе вузов, представлен количественно-качественный анализ на основе экспериментальной исследовательской работы. В частности, в статье дается теоретическое представление о цифровых технологиях, используемых в процессе подготовки будущих педагогов, рассматриваются их потребности и возможности в современных образовательных условиях. Речь идет о различных инструментах и ресурсах, используемых для создания и улучшения цифровой среды обучения в образовательном пространстве. Развивать мыслительные операции, формы организации обучения, развивать визуализацию, интеграцию идей и др. В ходе исследования сделан упор на построение системы интеллектуальных задач на основе цифровой педагогики, способствующей формированию навыков критического и творческого мышления.

В ходе экспериментального исследования был использован метод анкетирования среди студентов педагогических образовательных программ Карагандинского университета имени Букетова и Академии «Bolashaq». Опрос проводился через социальную сеть google. Были проанализированы результаты анкетирования, сделаны выводы и обобщены возможности, которые могут быть достигнуты с использованием цифровых технологий в процессе подготовки будущих педагогов.

Introduction. The Kazakhstani system of higher education, formed in the conditions of modern market relations, particularly defines the principle of considering the interests of students as one of the priority directions for successful solution of the tasks of training qualified personnel. In this regard, the introduction of competence–based approach in higher education system is one of the urgent issues requiring increased attention to the effective formation of higher education students' professional competences. By professional competence we mean personal knowledge, which includes knowledge, skills and professionally significant personal qualities, experience and value orientations that determine the productivity of performing professional tasks. This definition of professional competence requires significant changes in the pedagogical content of higher education curriculum, the use of digital technologies capable of training future professionals with the required integrated result. In the educational process of higher education no one disputes that traditional technologies are very important for professional development of a future specialist. However, it can be seen that their limitations are keenly felt since the emergence of the competence complex phenomenon. In this regard, digital learning will not be aimed at replacing traditional technologies, but at further improving the learning experience. In this regard, teachers at Kazakhstani universities face the task of improving digital literacy of students. At the same time, the pedagogical task of forming the personality of Kazakhstan citizen and his value orientations should be solved, since the educational process in higher education institution is the main component of the educational process in the life of each person.

The Law of the Republic of Kazakhstan "On Education" states that the main task of the education system is to create the necessary conditions for education, aimed at the formation and professional improvement of personality on the basis of national and universal values, science and achievements; introduction of new learning technologies, informatization of education, access to international global communication networks [1]. In order to solve these tasks through every teacher's daily search, there is a need for a transition to a new education, a new relationship, which opens up new horizons and ways to change. Therefore, every teacher should be able to accept and correctly use the necessary changes, information about different practices, and new methods in his or her activity.

Effective learning in upper secondary school does not involve only strong knowledge, but also the ability to apply it in different situations, self-education, problem-solving experience and modern digital literacy.

Therefore, it is necessary to organize a special pedagogical environment to prepare a modern competitive specialist. This means the widespread and systematic use of digital technologies in the learning process.

The level of research into the problem of implementing modern technologies in the process of training future teachers has been growing at an unusual pace in recent years. Research is being conducted in different directions. They include the works of O.F. Rudoy, E.V. Ashkinuze, E.V. Baranova, N.V. Bolotova, V.A. Dalinger, Y.A. Drobyshev, I.V. Drobysheva, E.V. Stepanova, M.N. Maryukov, I.V. Robert, A.S. Yakubov, I.M. Makarov, B.S. Gershunsky, A.P. Lapov, M.P. Lapchik, L.I. Gritsenko, E.A. Mashbitz, V.M. Monakhov, I.V. Robert, Croxall B., C.Kivunja, F.J.Rom, J.Mena, B.Singh, A.Clarke.

Researchers who have considered this issue at present in the country include S.T. Sirgebaeva, K.S. Ayazhanov, L.T. Kozhakhmetova, G.B. Sarzhanova, E.Y. Bidaybekov, J.K. Nurbekova, K.A. Ortaeva, E.A. Bogatyryeva, S.N. Isabaeva, A.N. Unembaeva, G.G. Sanai, A.E. Berikhanova, N.M. Ablyazimova, K.U. Karieva, S.S. Iyunbaev; S.N. Koneva; D.E. Sagymbaeva; A.B. Nurova; U.T. Nurmanalieva; B.Baimukhanov, B.D. Sydykov, R.S. Shuakbaeva, I.J. Esengabylov, G.A. Madyarova and others can be mentioned among them. However, the development and updating of digital technologies still need research.

Among the obvious reasons preventing the effective use of digital technologies in education is the lack of digital literacy in the training of future teachers. Therefore, there is a number of contradictions: the increasing role of digital resources between the state of the society and research development, their impact on different levels of education; lack of alternative manifestation of this role in the learning process; lack of methodological foundations for training future teachers on the basis of digital technology; high potential of digitalization as a means to enhance learning and teaching experience in higher education, do not use these opportunities in the full extent of contradictions. These contradictions determine the relevance of the study.

Methods and materials.

Prior to dwell on the issue of implementation of digital technologies in the process of future teachers' training, first of all, we should give the concept of "digital technology", "digital learning", "digital literacy".

Digital technology is a process of preparation and transfer of information to the student in the educational case, which allows to reveal not only the external nature of the studied phenomena, objects, processes, but also their inner essence, as well as the connections between the individual phenomena of nature and society.

Digital technology widely includes electronic devices, systems and data processing programmes. In such situation, this includes computers and smartphones, social media, artificial intelligence, and various programmes. And digital literacy is the ability to own and use these technologies, that is, the ability to find, evaluate and clearly communicate information across different digital platforms and other media.

Thus, general digital literacy is the set of knowledge, skills and abilities a person needs in order to use digital technology safely and effectively. Key aspects of digital literacy are:

– digital consumption – active use of the internet, internet media, social networks, cloud technologies;

– digital competences – knowing how to search for information, use digital devices, social networks, create multimedia content;

– digital security – ensuring the protection of personal data, using strong passwords, legal content and storing information.

The theory of 'digital learning' describes the patterns, principles and mechanisms of students' acquisition of subject knowledge, skills and competences, including computer–assisted learning. Digital learning is any form of learning accompanied by technology or learning practices that make effective use of technology. Digital learning may include any of the following: adaptive learning, gamification, blended learning, e–textbooks, learning analytic, learning objects, mobile learning, personalized learning, online learning (or e–learning), open educational resources, advanced learning with technology, etc [2].

The dynamic development of digital technologies in education is due to the relevance of a number of issues. As we note some of them are a tool for effective transfer of information and knowledge to students; a tool for creating learning materials; an effective teaching method and a tool for creating a new educational environment. Each of these issues is closely related to the Student himself/herself. It is very important that the Student, as a future educator, is involved in solving the mentioned problems, i.e. finding and transforming information, to create learning materials, and developing a teaching experience using digital technologies and gadgets himself/herself. Therefore, a two–way activity between teacher and student is necessary to make education productive.

– There are many tools and resources available online that can be used to create and enhance digital learning environments (most of which are free). Their aim is to improve the learning experience of students

by creating unique experiences. There are now many resources and tools that can be used in digital learning. Some of these include:

– RSS or social readers.
– Google+ Communities.
– YouTube channels.
– iTunesU.
– Quizlet
– Cloud word processors (Google Drive).
– File sharing platforms (Dropbox).
– Evernote.
– Digital folder.
– Зотерo.
– Video conferencing software(TrueConf, Улкейту, Cisco Webex, Microsoft commands).
– MagicBox.

It is self-evident that the importance of using digital technologies in the Higher Education process is increasing day by day. Due to the epidemiological situation in the world recently, it became evident that digital technologies are of great importance in connection with distance learning, educators and learners have been massively adopting online learning tools such as Skype or Zoom. Educational institutions have not only achieved widespread use of free Internet resource development, but also teachers with high digital literacy have quickly mastered paid platforms for implementing various educational content, ready-made cross-platform solutions, hybrid resources based on several platforms, etc. In order to increase students' learning motivation and interest in the subject matter. Some of the resources that our teachers successfully implement today are the distance learning system and the environment that enables the distance learning process: Moodle, Quizlet, Google (all functions offered by the platform Google) Microsoft Teams; e-learning platforms providing content for the implementation of e-learning (Socrative, Khan Academy); tools for educational communication: social networking communication services, messengers (Skype, WhatsApp), Yandex, Mail, Google services; modern tools for organizing teamwork or group projects: group interaction and discussion tools can include: Microsoft Teams online-service, Class Dojo [3].

The implementation of pedagogical technologies starts with students' independent work in a course on the discipline "innovative technologies in education", placed in a digital learning system. As a rule, at this stage students are given a problem task on the topics: "technological approach in education"; "the concept of pedagogical technology, subject, object, result of implementation", for which they have to get acquainted with the new teaching material and perform several tasks for self-control of their understanding. Independent work, started in a digital environment, continues with practical work in an classroom environment. The study of the discipline material is carried out by the future teachers performing interchangeable interrelated types of classroom and out-of-classroom learning activities. At the same time, the combination of digital technology elements makes learning more effective, cost-effective and convenient, and the learning process more interactive, person-centred and adaptable for all stakeholders, students complete projects in the learning process. Students are divided into teams and work in small groups. Moodle enables active interaction between students.

The learning process at our university is delivered through a modular, object–oriented, dynamic learning environment (moodle).

Features of Moodle:

– Installation of the platform through plugins. The functionality and design of Moodle can be modified through plug-ins, which can be downloaded free of charge from the internet or created by yourself.

– The system is open source. In the meantime anyone can do it. Plugins are usually developed by the users themselves and then put on the web for sharing.

– Integration with other services. Moodle is easy to integrate with other platforms such as WordPress or Zoom webinars.

The Moodle electronic environment has the ability to integrate resources and systematize the order in which they are read. When working with it, the learner can set the trajectory himself/herself, moving from a flash model to a training presentation, from an interactive map to a video clip. Obviously, all these tasks were previously integrated into the learning forms, but in the Moodle electronic environment all materials are systematized and can be quickly accessed using hypertext links. A task can be returned later and completed again, got quick feedback and discussed it with other course participants.

In the Moodle distance learning system, we aim to conduct organizational forms of learning based on conversation, mutual discussion, feedback during clarification. Moodle provides opportunities to consider a system of intellectual tasks that foster critical and creative thinking skills in the development of thought operations, visualization, integration of ideas etc. for each discipline topic. In particular, they can include:

– simple cluster assembly (from the English cluster) the use of methods for the main concept in the form of a graphical representation of the content characteristics of the concept, which leads to the definition, interpretation of new terms [4];

– drawing up a list of answers to a problem question by means of a written brainstorming session, which allows generating ideas [5];

– develop a list of preliminary discussion questions for a lecture in the form of a press conference [6].

We use as tasks to facilitate students' critical processing of information using digital learning tools while informing the new learning material of the lecture:

– complex cluster assembly–systematic set of concepts, terms written in the form of a hierarchically branched cluster and giving a visual representation of the lecture subject;

– denotat Graph (Latin for denotation) column method (Greek for grapho–writing) the main idea of which is that important concept symbols are extracted from the text and graphically to create a systematic understanding of the topic being studied [7];

– filling in tables: a comparative conceptual table to analyse phenomena under study, scientific theories and evaluate them according to self–defined criteria, or a summary table to summarize knowledge;

– independently formulate conclusions on an issue or on an entire lecture topic;

– graphically design the content of a lecture or part of a lecture in the form of a structural scheme reflecting the essential links between the objects and phenomena under study. Also, since the general educational purpose of seminars and practical forms of training is the practical consolidation, systematization of the theoretical material studied, checking the level of its assimilation, we actively use digital technologies in accordance with these forms of organization of training.

We apply each technology in a differentiated way depending on the general content of the seminar or practical session and the specificity of the topic. In this regard, the Learning Apps interactive task builder mentioned above has great potential when compiling various practical tasks based on the game method. This interactive task builder is designed to use the learning process with the help of interactive modules. Here you can create tasks of different levels of complexity. The main idea of interactive tasks that can be created through this activity is that students can check and correct their knowledge in a game form, which contributes to their cognitive interest in a particular academic subject [8].

In essence, in today's learning environment, digital technology is an irreplaceable opportunity to train competitive professionals. This is due to the fact that with this technology, if we teach from a scientific point of view, on the other hand, we achieve the formation of personality creative qualities in future professionals. Thus, it is safe to say that this learning technology has special importance for improving the quality of future teachers' training.

The main approaches to the implementation of digital learning technology in higher education are the individualization of learning, i.e. providing the necessary knowledge and skills aimed at the characteristics of each individual student, revealing his/her potential and helping him/her in further professional activity, as well as the interactive form and experience of learning. Individualization is also necessary to ensure that students' needs, expectations from the educational process and general education, since the student as an individual has his/her own individual requirements, compliance with which increases the student's motivation for learning activities and academic performance. Using digital learning technologies, the problem of mastery is very important because it is necessary to create the educational environment necessary for students to develop the conceptual problems of the discipline. In an e-learning system, teachers create special courses in academic disciplines that help students learn new material presented and arranged in a visual and contemporary way in the form of various videos, photos and audio. This allows students to engage in more detailed and engaging cognitive activities, which leads to quicker and easier assimilation of new skills and knowledge. Through the introduction of digital technology in education, students have the opportunity to learn new material in an interactive way, that is, through learning laboratories and various simulators created for the implementation of educational activities that will be aimed at the development of specific competencies and skills of students. The use of digital technology in education guarantees many opportunities and benefits that enhance the quality and efficiency of the educational process and make it pragmatic.

We combined a theoretical analysis of the problem with a practical study. In order to determine students' opinions and the level of digital technology use, we carried out a social networking survey (text of the questionnaire and link to an electronic resource, the results of which are presented in the list of 10 references used). The aim of the survey is to make a theoretical and practical study of the use of digital technology in the educational process of modern high school.

Objectives are set out in accordance with this aim:

– definition of the research topic relevance;

– scientific-theoretical analysis of the problem of the digital technologies use in the educational process of the Higher School;

– to reveal the importance of improvement of the digital technologies use in the educational process of the Higher School.

To carry out the diagnostics, we relied on a questionnaire developed specifically for this question, authored by O.I. Popova, candidate of sociological sciences of Russia. Students of pedagogical educational programmes of E.A. Buketov Karaganda University and Bolashaq Academy took part in the survey. 110 students were involved in the survey. The survey was formed of 4 questions [9].

Results. Based on the results of the survey analyzed the following points: digital technologies used in universities, the pace of development of digital technology in universities, students' understanding of the effectiveness of digital technology in higher education, digital technology, which are essential attributes of a modern university [10].

In the opinion of students, the following digital technologies are used at Universities: the need for blended learning (online + offline) – 46.4%, online courses – 27.3%, the availability of digital library – 13.6%, the availability of an electronic portfolio of the student – 15.5%, the spreadsheet on the website of the university – 30%, a personal account of the student–60.9% (Figure 1).

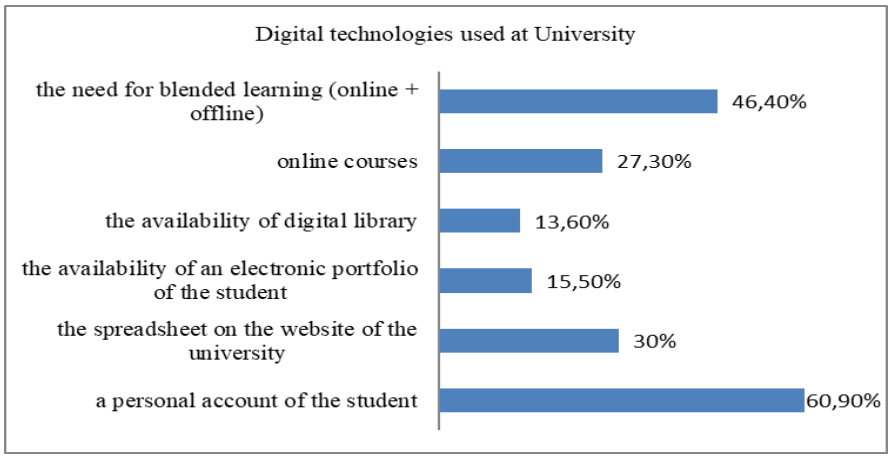

Figure 1. "What digital technologies are used at your University?"
(Source: authors–compilers themselves)

"What does the development of digital technology at universities affect?" According to the survey, the competitiveness of graduates in the labor market – 28.2%, the possibility of continuing education – 38.2%, the choice of university applicants – 13.6%, the promotion of universities in international space – 15.5%, the competitive advantages of the university – 13.6%, improving the quality of education – 40.9%, convenient training of students – 52.7%.

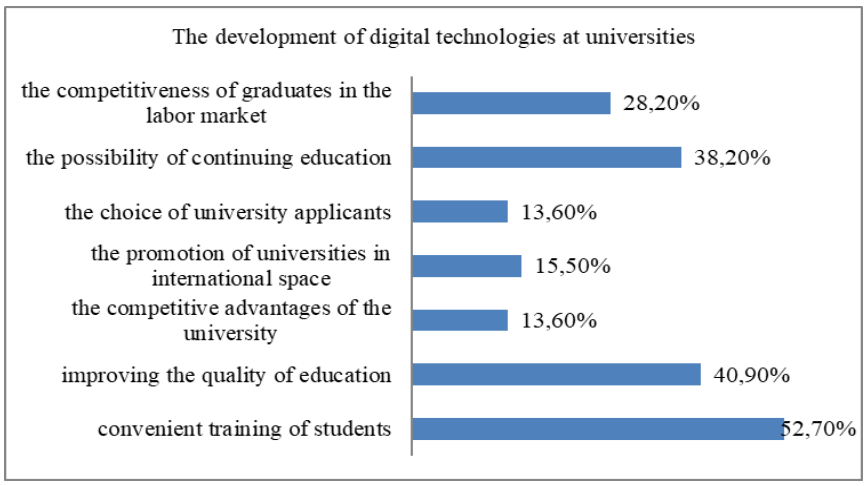

Figure 2: "What does the development of digital technologies at universities affect?"

Upon the request "what can students gain from the use of digital technology in higher education?" students answer on next way: will allow students to gain skills in digital technology – 44.5%, will create interest and motivation for learning activities – 32.7%, will read educational material 24/7 – 44.5%, will make learning easy and understandable – 27.3%, will save time on training and preparation – 42.7%.

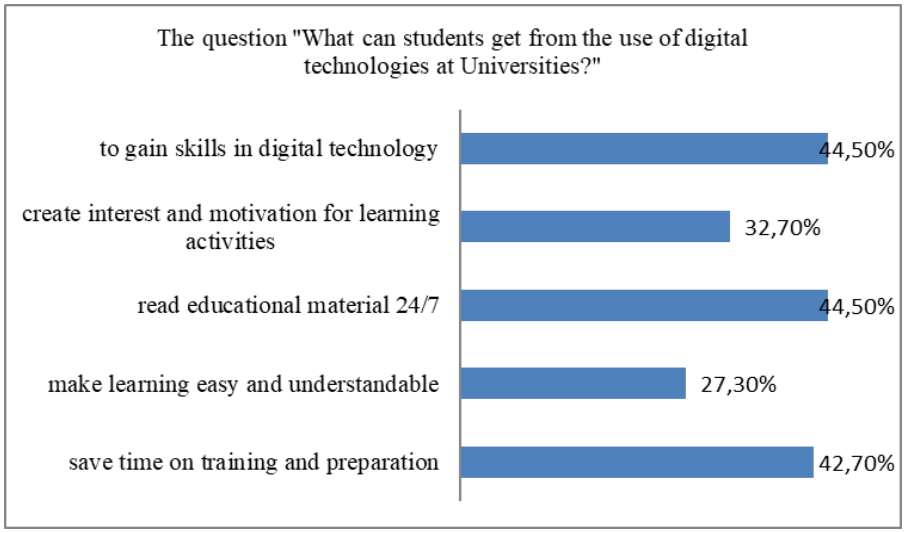

Figure 3. "What can students get from the use of digital technologies at Universities?" (source: authors–compilers themselves)

The students' answers to the question: "In your opinion, what digital technologies are necessary attributes of modern universities?" are the following: digital campuses on demand – 7.3%, electronic student portfolio – 19.1%, blended learning (online + offline) – 25.5%, online courses – 21.8%, distance learning – 60.9%, digital library – 23.6%, spreadsheet on the university website – 20%, electronic textbooks and manuals – 26.4%, student personal account – 37.3%.

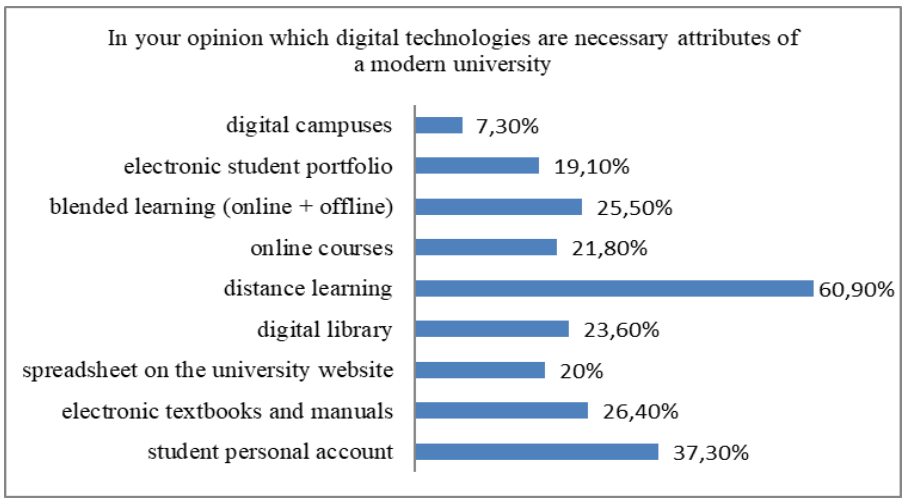

Figure 4: "In your opinion, which digital technologies are necessary attributes of a modern university? (source: authors–compilers themselves)

D**iscussion.** From the survey conducted in connection with the determination of the attitude of students to the use of digital technologies in the educational process of Higher School, we are convinced that the issue of its implementation is relevant, needs to be considered. Because digital technologies inevitably affect the process of training a competitive specialist. Therefore, it is an urgent area of work for Higher Education administrators and academic staff. Students expect to achieve the following tasks by using digital technologies: satisfaction with the learning process, ease of learning, interest and continuity through convenient learning, relevant education, time saving and 24/7 learning opportunities anywhere in the world, learning from world leading practitioners and specialists. Of course, we cannot say that digital technologies are not used at all in the process of training future teachers, but the way to implement them today in the field of professional education still needs to be improved.

By using digital technology as a necessary complement to traditional education in higher education, we obtain a large base of learning materials necessary for learning work, namely:

– achieving the implementation of the learning material initiative;
– conducting frontal questioning in a group;
– writing, completing assignments on topics in the higher education curriculum;
– automatically check the assignments completed by the students;
– keeping statistics of discipline and studied topic ;
– the possibility of students' instant access to view the results.

Digital technologies in the learning process should be presented due to learning the degree of students' increasing complexity in accordance with the regularities of the cognitive process in learning. Their implementation leads future teachers to significant optimization of knowledge assimilation, allows solving homogeneous tasks, seeing the dynamics of intellectual development, contributing to the development of independence. Thus, digital technologies in modern education stimulate students' learning activities, organize independent work, help to distribute forces evenly in the process of mastering the discipline, use time effectively, and also allow to understand the practical orientation of formed knowledge, abilities, skills, reflecting the role of certain technologies in performing control and assessment tasks. Based on the theoretical and experimental analysis of the problem, the following conclusions can be drawn:

1. Digital technologies will inevitably affect the development brand of universities. Therefore, university management and teaching staff should pay special attention to this issue. The development of digital technology at university affects the improvement of the quality of education in the labour market.

2. Students do not directly associate digital technology with the development of the university. But they do expect the implementation of mandatory functional elements of university development: convenience of learning, up-to-date knowledge, time saving and satisfaction with the learning process due to the possibility of learning 24/7 anywhere in the world, ease of learning, interest and continuity of learning from the world's leading practitioners and specialists.

3. Distance and online learning are important for students: more than half of the respondents noted the need for distance learning at Universities and online courses. However, students are not ready to completely abandon communication with the teacher in the classroom.

Conclusions. Thus, the implementation of digital technologies in the training of future teachers enables to achieve:

– an improvement, development knowledge through various informational, pictorial, sound definitions comprehensively;

– a performance of differentiated tasks independently;

– an opportunity to refresh or additionally repeat their knowledge at any time;

– a deep interest in the subject, continuous searching;

–an improvement of the ability to communicate his/her play in the form of drawings, pictures, figures, tables and graphic models;

– a performance of various video, referencing, instructional tasks;

– a checking the acquired knowledge by completing test tasks of different levels.

At present, the use of digital technology is not giving students a large amount of material, but training the teacher to further develop their knowledge in a real reference account, determining the essence, specificity, qualitative level of each phenomenon.

In one article it is impossible to consider all aspects of the problem arising in the professional training of the future teacher in connection with the implementation of digital technology. However, we believe that the use of digital technologies in the preparation of future teachers is an important tool to facilitate the formation of a modern professional mature specialist. Therefore, effective implementation of these technologies in the learning process is a requirement of the time.

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БОЛАШАҚ ФИЗИКА МҰҒАЛІМДЕРІН ДАЯРЛАУДА 3D МОДЕЛЬДЕУ ТЕХНОЛОГИЯСЫН ҚОЛДАНУДЫҢ ЕРЕКШЕЛІКТЕРІ

Аңдатпа

Физиканың ғылым ретінде дамуы және физикалық құбылыстар мен заңдылықтарды зерттеу әртүрлі физикалық жүйелердің модельдерін құрумен тығыз байланысты. Физиканың эксперименттік ғылым екендігін және физиканы оқытуда кейбір құбылыстарды түсіндірудің қиындығын ескерсек, бұл мәселені шешудің ғылыми негізделген тәсілін, жеңілдетілген баламасын құру өзекті болып табылады. Бұл зерттеудің мақсаты 3D модельдеудің физикалық зертханалық жұмыстарды орындаудағы тиімділігін айқындау болып табылады. Сонымен қатар, болашақ физика мұғалімдерінің танымдық қабілеттерін, пәнге қызығушылықтарын дамытуда 3D модельдеуді қолданудың мүмкіндіктері мен ерекшеліктерін анықтау. Зерттеу барысында теориялық және эмпирикалық әдістер, зерттеудегі сандық-сапалық әдіс элементтері, моделдеу әдісі қоладнылды. IT-білім, роботатехника элементтері, электрондық оқыту ресурстары сарапталды және 3D негізді компьютерлік бағдарламалар таңдалды. Рецензияланатын жоғары рейтингті журналдарда жарық көрген ғылыми әдебиеттер зерделенді, 3D виртуалды шындықты модельдеу және оның білімгерлерге физикалық құбылысты түсінуіне ықпалы 32 студентке жүргізілген сауалнама арқылы расталды. Зерттеу нәтижелері көрсеткендей оқытудың дәстүрлі түрлерімен қатар, 3D модельдеу технологияларын енгізу оқыту тәжірибесін едәуір кеңейтіп, білім сапасын арттырады.