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THE USE OF INFORMATION TECHNOLOGIES IN THE EDUCATIONAL SPACE OF UKRAINE (ON THE EXAMPLE OF STEAM TECHNOLOGIES)

EL USO DE TECNOLOGÍAS DE LA INFORMACIÓN EN EL ESPACIO EDUCATIVO DE UCRANIA (EN EL EJEMPLO DE LAS TECNOLOGÍAS DE VAPOR)

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ABSTRACT

In the process of experimental research, we proved the necessity of using information technologies in the educational process of higher education institutions; the content of research concepts is revealed. A cloud-oriented system of using information technologies in the educational space of a higher school was built, the basis of which are specific principles of using information technologies, professionally oriented information technologies in the educational space of a higher school, and the main methods of professional training of future specialists, STEAM technologies, which made it possible to form future specialists relevant professional competences. In the process of research, the levels and elements of readiness of the future competitive specialist to use information technologies are distinguished. The study allowed higher education students to use computer simulation programs to create educational complexes for self-education, which is the most effective form of using information technologies in education. During the study, effective specific principles of using information technologies were identified: the principle of distribution of educational and methodical material; the principle of interactivity in the organization of the educational space of the higher school; the principle of modularity of education; the principle of accessibility in the education system when presenting the content of education; the principle of adequate assessment of knowledge and feedback.

Keywords:

Information technologies; education; institutions of higher education; STEAM technologies; cloud-oriented system of using information technologies.

RESUMEN

En el proceso de investigación experimental comprobamos la necesidad de utilizar las tecnologías de la información en el proceso educativo de las instituciones de educación superior; Se revela el contenido de los conceptos de investigación. Se construyó un sistema orientado a la nube para el uso de tecnologías de la información en el espacio educativo de una escuela superior, cuya base son principios específicos del uso de tecnologías de la información, tecnologías de la información con orientación profesional en el espacio educativo de una escuela superior y los principales métodos de formación profesional de futuros especialistas, tecnologías STEAM, que permitieron formar a los futuros especialistas en competencias profesionales relevantes. En el proceso de investigación se distinguen los niveles y elementos de preparación del futuro especialista competitivo para el uso de tecnologías de la información. El estudio permitió a los estudiantes de educación superior utilizar programas de simulación por computadora para crear complejos educativos para la autoeducación, que es la forma más eficaz de utilizar las tecnologías de la información en la educación. Durante el estudio, se identificaron principios específicos efectivos del uso de tecnologías de la información: el principio de distribución de material educativo y metódico; el principio de interactividad en la organización del espacio educativo de la escuela superior; el principio de modularidad de la educación; el principio de accesibilidad en el sistema educativo a la hora de presentar los contenidos de la educación; el principio de evaluación adecuada del conocimiento y retroalimentación.

Palabras clave:

Tecnologías de la información; educación; instituciones de educación superior; tecnologías VAPOR; sistema orientado a la nube de uso de tecnologías de la información.

INTRODUCTION

In the modern world, the rapid development of information technologies contributes to the active transformation of education by diversifying the forms and methods of the educational process, processing, assimilation, and improving the procedures for obtaining the necessary information. Reforming the education system, in the general context, requires the construction of an educational process with the use of information technologies in educational institutions in conditions of widespread use of computer technology and development, which contributes to the intensive development of students of higher education, humanization, differentiation, humanization of education, the realization of intellectual and spiritual potential young people (Romanukha et al., 2019).

Informatization has become mandatory when acquiring a profession, therefore more and more young people, due to the speed and optimization of independent obtaining of information, pay great attention to professions and education related to information technologies (Kryvonos, 2022).

Literature review

Information technologies are necessary for education and provide an opportunity to change the model of the educational space: they provide a transition from reproductive learning to a creative model. Information technologies, with the help of new technical and technological support, contribute to the simulation of life situations or the educational process, provide an opportunity for students of higher education under the guidance of a teacher: to develop a solution to a given task, to show creative abilities, to apply their knowledge to analyze a simulated situation, etc.

The use of information technologies in the educational space of a higher school is the subject of many scientific studies in pedagogy, philosophy, and psychology. These are the researchers who have fundamental research on the use of information technologies in the educational space of a higher school.

Hurevych et al. (2020), with the aim of effective use of web technologies and information and communication technologies in the training of specialists, analyzed the ways of using the information educational environment in a higher education institution and showed the importance of the use of information technologies in the future professional activity of specialists; proved the importance of using cloud services to form the skills of working with web technologies and electronic educational and methodological complexes in students of higher education. To form in future specialists the ability to provide technological processes in education and to use various technologies and automated systems, the students gave examples of the use of information and communication technologies and web services. This problem is investigated by Kryvonos (2022), an overview of the opportunities provided by information technologies was carried out in the modern educational space; with the use of information and communication technologies, examples of successful application of information technologies in education are considered, negative and positive sides of the organization of the educational process are shown, and advice on their solution is described, and methodical advice for scientists is developed. The methodological recommendations were developed by Pshenychna (2020), aimed at the assimilation

of theoretical knowledge by master's students in the discipline "Information technologies in higher education" and their acquisition of skills in working with software and practical skills in professional activities, which allows future specialists to implement educational activities effectively.

According to Romanukha et al. (2019) reviewed information technologies in the education of the 21st century. and revealed the principles of forming the e-textbook of the future. Using specific examples, the role of STEAM technologies is demonstrated, their content, interest, and practicality for the future are revealed; taking into account the development of information technologies, the role of visualization in education and understanding the assimilation of information is emphasized; the role of information technologies in their formation and the role of speech and language competences of the individual are investigated.

The authors Rebenok & Torubara (2023) proved that society needs specialists who are fluent in ICT and use them effectively in their professional activities; revealed the peculiarities of the use of ICT by future specialists in the educational process of higher education institutions, characterized the peculiarities of the mental development of higher education students before the use of these technologies.

Therefore, the vectors of the development of the scientific opinion of scientists regarding the specifics of the use of information technologies in the educational space of a higher school are represented by thorough research in the scientific fund, and the terminological and substantive interpretation of the concept of information technologies in the educational space of a higher school has repeatedly been the subject of scientific study by various scientists.

Considering the relevance of the topic of our research and the inadequacy of the theoretical and practical components, we set the **GOAL**: to prove the importance of the use of information technologies in the educational space of a higher school and experimentally verify the effectiveness of a cloud-oriented system of using information technologies in the educational space of a higher school.

MATERIALES Y MÉTODOS

In the process of researching the use of information technologies in the educational space of a higher school, a complex of the following necessary methods was applied, which ensure the achievement of the set goal:

- theoretical: systematic analysis of literature and scientific research to compare different views on the organization of the educational process and on the problem of using information technologies in the educational space of a higher school, analysis of the training of future specialists through the use of information technologies in the educational space of a higher school;
- empirical: the use of questionnaires, interviews, interviews, and observation methods to study the specifics of the use of information technologies in the educational space of a higher school, in the process of professional training;
- conducting a pedagogical experiment to collect data on the effectiveness of the use of information technologies in the educational space of a higher school;
- statistical: processing and recording the results of the experiment (using computer programs, in particular, MS Excel and SPSS) for statistical processing of the obtained data to prove the importance of using information technologies in the educational space of a higher school.

In the process of experimental research, we proved the necessity of using information technologies in the educational process of higher education institutions; the content of research concepts is revealed. A cloud-oriented system of using information technologies in the educational space of a higher school was built, the basis of which are specific principles of using information technologies, professionally oriented information technologies in the educational space of a higher school, and the main methods of professional training of future specialists, STEAM technologies, which made it possible to form future specialist's relevant professional competences.

In the research process, the levels and elements of the future competitive specialist's readiness to use information technologies were identified: the future specialist's own level of mastery of computerized technologies; the individual's ability to directly use information technologies in professional activities; the ability to improve one's professional level with the help of the Internet. The study allowed higher education students to use computer simulation programs to create educational complexes for self-education, which is the most effective form of using information technologies in education.

Graduates of higher education combined Simulink and Matlab programs, which made it possible to optimize systems, generate them, analyze them, and create a wide range of toolboxes. The Matlab graphics system contains high-level commands for three-dimensional and two-dimensional data visualization, animation, image processing, and graphing. The Partial Differential Equation (PDE) application is designed to solve problematic tasks. The Symbolic Math application made it possible to perform statistical calculations in the Matlab environment, and the System Identification package was included in the set of tools intended for the identification and evaluation of

systems. Such programs are necessary during laboratory classes.

During the training of specialists, it was necessary to model processes using S-models. Virtual reality technology, which allowed students to model, project, visualize, and explore, was of great importance for quality education.

Experimental data were processed using the Pearson $\chi 2$ criterion, which gave grounds for concluding that the hypothesis was correct and the feasibility of introducing the developed and proposed cloud-oriented system of using information technologies in the educational space of a higher school.

The processing of experimental data by mathematical methods gave the basis for a conclusion about the expediency of introducing the developed and proposed cloud-oriented system of using information technologies in the educational space of a higher school.

RESULTADOS-DISCUSIÓN

Nowadays, computerization has been deeply integrated into human activity, which is related to the storage and processing of information, the organization of financial, material, and intellectual flows, production management, and the provision of reliable communication, which has become an almost integral part of human life. The need to use ICT in the educational process of institutions of higher education, where information is increasingly taking on the role of a socially significant resource, is due to the urgent need to train such future specialists who, in the conditions of modern society, are capable of realizing their professional functions, because society needs such specialists who are fluent in ICT and effectively use them in their professional activities. Such professional training means the formation of future specialists' ICT application skills and competencies of quick orientation in the information space to successfully solve professional tasks in future activities. Future specialists must have, first of all, experience working with modern ICT, know the possibilities of ICT, and not only possess knowledge in the subject field (Rebenok & Torubara, 2023).

The content of research concepts

The educational space is considered as a dynamic, complex, integral, open "subsystem of the social space, in which educational activities are carried out and the formation and formation of the personality and the acquisition of certain basic and professional competencies by it" (Hurevych et al., 2020).

For the effective implementation of the educational process, the informatization of education relies on the use of potential opportunities of communication and information technologies, creating conditions at all levels of education: to a post-graduate education institution – from a preschool institution (Kuchai et al., 2020).

Let's name the main concepts related to the informatization of education:

- Information technologies;
- Information and communication technologies (ICT);
- Information technologies in education.

Therefore, the informatization of education is understood as "...an ordered set of interrelated organizational-legal, socio-economic, educational-methodical, scientific-technical, production and management processes aimed at meeting information, computing, and telecommunication needs associated with opportunities methods and means of information and communication technologies of participants in the educational process, as well as those who manage and ensure this process" (Pshenychna, 2020).

Information technology is a useful and integral component of the professional and educational process, which allows both teachers and students to develop creativity, optimize all processes related to learning, better remember and perceive material, and constantly develop themselves in the computer information industry. In the context of the uniqueness and individuality of each student, there is a big problem. It is possible to optimize the learning management process only based on clear quantitative and qualitative characteristics of the level of intelligence, which is achieved by the target program individually by each person. In the educational space of training specialists, it is possible to create a system of automated training with a substructure of diagnostics, and control, based on appropriate tests ordered according to IQ (Kryvonos, 2022).

A cloud-oriented system of using information technologies in the educational space of a higher school

As learning in the educational space of higher education becomes increasingly digital, access to the Internet becomes more important. A cloud-based system in the higher education space can provide services such as remote access to learning tools to save money in a cost-effective way through state and local funding. Cloud computing provides an opportunity to transform pedagogy with services adapted to the needs of future professionals (Kuchai, 2017).

Students of higher education can access classes on a phone, tablet, or laptop from anywhere and use them freely. At the same time, the student of higher education, to help others, can answer questions, ask questions, and

share what he has learned. Access to user data and analysis means that such a system can be adapted to ensure maximum effectiveness of the education system and users. It helps higher education aspirants to access learning from any teacher with relevant experience, anytime, anywhere, anytime.

The content of education, which is based on the use of cloud-based systems, is considered an opportunity to transfer educational information, to ease the burden of the educational process on teachers, as the development of critical thinking, understanding of what has been learned in the context of using, etc. The skills most often acquired by students through interaction with each other and teachers, which are necessary for the creation of electronic computing resources, serve to build individual components of a cloud-oriented system. These interactions can be online, in real-time, or both, but in a given field, expert guidance will remain an important part of the hands-on learning experience.

A cloud-oriented system, for most of the leading educational technologies, provides an opportunity to redefine the role that ICT plays in the implementation of the education strategy.

Thanks to Google tools, higher education teachers have more opportunities for professional development, are more successful in creating interactive activities for their students, are more efficient in solving administrative tasks, participate more in collaborative educational projects, and higher education students use online applications more, take participation in events, are more creative, better understand the content of education.

Specific principles of using information technologies in the educational space of higher education

During the research, we selected a collection of the most effective specific principles of using information technologies:

1. The principle of distribution of educational and methodical material provides for the use by students of higher education:

- local, autonomous software tools;
- training manuals in “hard copy”;
- methodical support of the educational space of the higher school;
- elements of the electronic educational and methodological complex and educational modules.

2. The principle of interactivity in the organization of the educational space of a higher school involves the implementation of pedagogical interaction (those who study and those who teach) in the environment of a higher education institution.

3. The principle of modularity of education provides for the construction of content in the form of separate sections and a general educational course, each section of the course is divided into small didactic units (forms, types, topics of activity), which are intended to facilitate the achievement of specific goals of the educational process.

4. The principle of accessibility in the education system when presenting educational content is implemented:

- interactive elements, to ensure the connection of concepts existing in educational modules;
- methodological instructions in the modules for the implementation of individual research projects, independent tasks, control, practical, and laboratory works;
- methodical guidelines for implementing pedagogical interaction in a computer-oriented environment of a higher education institution.

5. The principle of adequate assessment of knowledge and feedback provides for the teacher to receive data on the completion of tasks, test results, and mastering of educational material by the students of higher education. This principle is implemented in the computer-oriented environment of a higher school with the help of:

- the interactive resource “Assignment”, in which the teacher receives a report (file or text) uploaded electronically to the server from students of higher education. For example: projects, abstracts, messages, reports, etc.;
- an electronic rating system that provides an assessment of the success of higher education applicants, which is based on the following indicators: monitoring the skills, knowledge, and possessions of the higher education applicant, the total volume of the educational discipline, and the comprehensive assimilation of knowledge, which accumulates the indicator, to determine the education applicant’s success (total rating) for a certain period of education; assessment of the level and scope of learning by the student of educational material (marginal rating) of one module of the discipline;
- the interactive resource “Tests”, which provides pedagogical control in the form of testing, which allows students to independently identify gaps in their knowledge and take measures to eliminate them. The use of the considered specific principles of the use of information technologies in the educational space of higher education and the means of interaction of higher education applicants “collectively determines the methodological basis of the organization of level information technology training of students” (Antoniuk et al., 2019).

Professionally oriented information technologies in the educational space of a higher school and basic methods of professional training of future specialists

Professionally oriented information technologies in the educational space of higher education, which are necessary for the training of future specialists, include:

- cloud-oriented learning tools (tools for working on joint projects, compilers, intellectual maps, etc.);
- a cloud-oriented learning support system in the educational space of higher education;
- mass open online courses;
- web-oriented automated systems for conducting competitions.

In the educational space of higher education, we suggest using the following methods of professional training of future specialists:

- The research method is convenient for consideration of debatable issues within the problem group, during remote communication, and student conferences (video conference, webinar, etc.).
- Explanatory and illustrative methods – in the cloud-oriented learning support system in the educational space of higher education, it is possible to upload video files to the data storage for further viewing by students of higher education (lectures-presentations, video-lectures, additional illustrative materials placed in the cloud, on- online chats, online consultations, etc.); also, massive open online courses on the Udemy platform provide training of future specialists with video materials from leading scientists from around the world. Lectures and presentations placed in the cloud can be used both independently by students outside of school hours and during a teacher's session. Explanatory and illustrative methods in the study of the material provide visibility and are also used within the subject or problem group to provide group and individual consultations to students of higher education.
- Project method – automated systems of programming competitions (TopCoder); tools for working on joint projects (Mindmeister, Gantter.com), cloud-based tools; compilers focused on project-based joint activity of higher education students, where they manifest themselves in joint activity on a software development project or a scientific project (Kontsedailo & Vakaliuk, 2018). During joint project activities, future specialists learn to draw up an action plan, work together on a problem, distribute responsibilities, create and present the final product, etc.
- Heuristic – the teacher offers to realize the educational goal to complete a joint project in other cloud-oriented learning tools that are not typical and offers a non-typical task placed in web-oriented systems.
- Makhmutov method – this method is used to promote collective problem-solving, to work on a joint project using cloud services, and to create a problematic situation (Antoniuk et al., 2019).

STEAM technologies in the educational space of a higher school

New requirements for specialists in various fields, in particular, and changes in the labor market, in general, require the involvement of innovative teaching methods in technical education institutions. Adaptability, critical thinking, and creativity of the individual have become the main features that a sought-after specialist must have. Therefore, modernity requires the teacher to realize his creative potential, to direct the student of higher education to self-education, and not only to provide educational material. That is why the use of modern technologies in the educational space, the integration of various disciplines, and the informatization of education are currently the leading educational trends. All these are components of STEAM technologies, which are necessary in teaching professional disciplines and can take the following forms:

- consideration of professional phenomena through the prism of other sciences;
- use of statistical calculations, and methods of mathematical analysis;
- substantiation from a historical perspective of certain discoveries, scientific processes, technological changes, etc.;
- use of game technologies;
- involvement of the applied aspect (development of projects for generalization and deepening of knowledge, creation of figures, models, construction of associative links);
- emphasis on the creative development of students;
- encouraging the use of tablets, smartphones, and laptops for educational purposes;
- creation of visual boards, online platforms, etc.;
- translation into the format of online textbooks, dictionaries, and manuals;
- involvement in the education of social networks, use of appropriate tools, and creation of thematic pages.

The main educational task of the higher school is the comprehensive training of competitive and qualified specialists. Therefore, the ability to adapt to changes, mobility, quick adaptation to the situation in the labor market, and constant improvement of one's professional skills are

necessary for a graduate of a higher education institution today.

The appropriate professional competencies of higher education students help to form modern STEAM technologies, which organically combine the principles of integration of mathematical, natural, and humanities, designing the activation of creativity and the involvement of computer technologies.

Let's list the current trends in modern education that are implemented thanks to STEAM technologies:

- use of general use programs such as Skype, messengers, Microsoft, etc., and special educational programs (language simulators, visual planetariums, etc.);
- use of technical means (3D printers, smartphones, computers, etc.);
- syncretism of educational subjects, interdisciplinary connections;
- use of online versions of manuals, electronic textbooks, encyclopedias, etc.;
- gamification of education;
- involvement of mobile applications;
- stimulation of students of higher education to involve elements of engineering in education, experiments, and inventions;
- emphasis on the cultural significance of information for the individual (Romanukha et al., 2019).

The main directions of the use of computer technologies in the educational process of the institution of higher education and the main components of the computerization of education

We will highlight the main directions of using computer technologies in the educational process of a higher education institution:

- for a visual representation of physical processes and modeling of the professional situation occurring in the technical devices under investigation;
- for automated training;
- for and demonstration of the main objects and concepts of the professional discipline, its visual representation of the main regularities, the connection with the practice of theoretical provisions, etc.;
- for processing the measurement results of experimental studies, solving calculation tasks;
- for design automation;
- for monitoring the preparedness of higher education applicants (Kuchai & Demianiuk, 2021).

Software development is an important component of the computerization of education. Programs used in higher education institutions are divided into:

- educational (contribute to the assimilation of new information, guide training taking into account the available individual abilities of the students of education and their knowledge);
- training (intended to consolidate and repeat the material covered);
- diagnostic (intended for assessment, knowledge verification, diagnosis of abilities, skills);
- imitative (to study the main functional or structural characteristics, they present a certain aspect of reality with the help of isolated parameters);
- databases (repositories of information from various fields of knowledge);
- modeling (display types of functions, and main elements and simulate a certain reality);
- instrumental software tools (ensure compilation of tables, text processing, execution of specific operations, editing of graphic information);
- programs of the "microworld" type (similar to simulation ones – create a virtual educational environment, simulate, but do not reflect reality).

Levels and elements of readiness of the future competitive specialist to use information technologies

One of the main requirements for teachers and students at the current stage of technological and social transformations of society is the readiness of the future competitive specialist to use information technologies and computerized systems in professional activities and education. The following readiness levels are distinguished (Semenikhina et al., 2020):

- the future specialist's own level of mastery of computerized technologies;
- an individual's ability to directly use information technologies in professional activities;
- the ability to improve one's professional level with the help of the Internet.

Important elements of this readiness are:

- practical skills of the teacher to conduct an organized educational session with the help of computer technologies and tools;
- the ability to prepare an educational session based on the distance form of the educational process;
- theoretical training in a certain field of knowledge

- application of the development of electronic teaching aids;
- introduction of websites into the educational process to deepen one's teaching and scientific competence.
- creation of one's own electronic study guide for a specific professional discipline.

Therefore, the teacher must possess specific, certain skills to effectively use modern information technologies in the educational process (Plakhotnik et al., 2022):

- to effectively combine traditional teaching methods with new information technologies;
- select rational teaching tools and methods;
- to apply modern information technologies in the analysis, preparation, management, and adjustment of educational and cognitive activities of higher education applicants and the educational process;
- take into account the inclinations and abilities of the individual and his individual characteristics.

Active use of new information technologies in the educational process of higher education

The objective process of education development is the introduction of new information technologies into the educational process of higher education. Just as none of the technologies can be considered universal, they should not be thoughtlessly used by teachers (Vakulyk et al., 2023).

In the process of our research, it was found that teachers of higher education institutions actively use cloud services that provide higher education students with network access to a flexibly organized and scalable pool of distributed virtual or physical resources that are delivered in administration and self-service mode at their request (for example, computing power, space for data storage, software, etc.) to create higher education students:

- joint documents (forms, blogs, tables, calendars, presentations, etc.);
- didactic resources (Learning apps, Studystack, Classtools.net, Prezi, Zondle);
- knowledge maps (MindMeister, SpiderScribe.net, Mindomo Basic, Bubble.us), etc.

An integral feature of the construction of the cloud infrastructure of the ICT environment is a unified data storage architecture, which is aimed at managing large volumes of data and comprehensive storage of this data (Hurevych et al., 2020).

The active use of new information technologies in the educational process of higher education is characterized by:

- modeling programs that allow, in the process of using sets of arbitrary parameters during classes, to obtain dynamic and static display of calculation results;
- effective management of a large volume of lecture material is provided by computerization of demonstration support for lecture work;
- the teacher has the opportunity to: present on the screen the constituent parts of the object or the entire researched object, examine the constituent parts from different angles, demonstrate to students of higher education the peculiarities of the course of complex processes and phenomena, look into the middle of the researched object, enlarge the image of the object, simulate the operation of laboratory stands, machines, units with the possibility of setting and changing boundary and initial conditions, moving "deep" into the screen, etc.;
- multimedia computer demonstrations have the greatest didactic effect because they allow the simultaneous use of animation, three-dimensional graphics, sound, and video plots (Rebenok & Torubara, 2023).

The role of computer simulation programs in the creation of educational complexes

The creation of educational complexes is the most effective form of using information technologies in education, consisting of the set and methodical development of computer simulation programs (Plakhotnik et al., 2023). During the classes, future specialists have the opportunity to analyze the obtained computer model, make changes to the conditions of the process, make quantitative measurements, and solve the problem by choosing the optimal parameters. They play the role of researchers within this work, conduct an experiment, and interpret the result. The program provides for the possibility of choosing an individual pace of work, and repeated use of the material.

The program includes a bank of control questions and tasks, which makes it possible to conduct an objective control of the knowledge of future specialists during a laboratory session.

The combination of Simulink and Matlab programs provides an opportunity for system optimization, generation, analysis, and the creation of a wide range of instrumental professional applications (toolboxes). The Matlab graphics system contains high-level commands for three-dimensional and two-dimensional data visualization, animation, image processing, and graphing.

The Partial Differential Equation (PDE) application is designed to solve problematic tasks (Kravchenko et al., 2022).

The Symbolic Math application enables you to perform statistical calculations in the Matlab environment.

A set of tools designed for system identification and evaluation includes the System Identification package. During laboratory classes, such programs are necessary for use in the process of studying professional disciplines. Under the condition of modeling a certain range of tasks, the use of professional Matlab software applications will make it possible to visualize the results of the conducted experiment, facilitate the compilation of multilevel models, highlight the main directions of the development of computer modeling, and attract future specialists during the teaching of professional disciplines to scientific research.

During the training of specialists, it is necessary to model processes with the help of S-models, which is characterized by:

- a set of effective professional training programs (Solvers) for future specialists implementing methods of numerical integration of differential equations with an automatically changing variable step of integration, with a fixed step of integration, as well as rigid systems of differential equations;
- the possibility of very convenient and quick obtaining of graphical information about changes over time of simulated values;
- the effectiveness of creating modeling programs from standard ready-made blocks of complex dynamic systems, by drawing up a system block diagram, which are visual representation of mathematical programs;
- unique opportunities for integration with significant non-linearities of the equations of non-linear systems;
- absence of the need for numerical integration of differential equations in a special process organization.

The computer greatly speeds up the learning process, which allows you to expand the range of exercises, study a larger amount of information, and more carefully consolidate the studied material, which enables teachers to pay more attention to aspects of creative work in the process of studying professional disciplines for future specialists (Stratan-Artyshkova et al., 2022). It is appropriate to use computer models to study processes that are not available for direct observation, have a probabilistic nature, and are associated with the use of expensive, complex equipment. Working with them makes it possible to avoid such typical shortcomings of traditional laboratory work a mechanistic nature and a creative character. In the educational process, future specialists can create computer models of the simplest units, demonstrating their work on the screen. In this case, the computer performs the entire experiment on its own, and the future specialist plays a passive role, not realizing the meaning of these actions, pressing only the buttons. Equipped with a set of software and a computer, automated workplaces make it possible to provide automated research and design of equipment operation in the process of modeling production processes (Shuliak et al., 2022).

Nowadays, the technology of "virtual reality" is of great importance for education, with the help of which it is possible to model, project, visualize, and study the course of processes in engines, aggregates, biological systems, etc. In the USA, Great Britain, and other developed countries, the technology "virtual reality" is given a lot of attention. Today, technical complexes, and mobile and controlled robots developed in various fields of technology and science are used in education (Kuchai et al., 2022). The specified technology is used to study modern equipment (Virtual Computer Integrated Manufacturing, Virtual Robot), learning (Automated Manufacturing Technology) automated production technology (Shetelya et al., 2023). Working with such systems of higher education students enables them to:

- "feel" yourself inside the virtual space, "feel" yourself a part of this system;
- research and model phenomena in the role of an outside observer;
- to be ready for future professional activity;
- develop research skills, skills, test and propose hypotheses;
- to carry out scientific research, where students of higher education play the main role.

Modern means of information technologies make it possible to hold various conferences, organize seminars, and "round tables" on the Internet with the participation of students, teachers, and interested persons during which information is exchanged in the network during work.

The use of global networks is expanding for implementing various joint projects. One of the most important tasks of training future specialists using modern approaches and software tools is the inculcation of skills and abilities to collect significant professional information.

American DADS, ADAMS in the educational process of higher education are universal software complexes, the use of which allows you to dynamically analyze the behavior of elements and the entire designed system during operation and automate the development of models of mechanical complex systems. The results of such work make it possible to correctly choose design parameters, assess safety, performance, and other qualities

of the system, and determine the load for further design (Rebenok & Torubara, 2023).

Experimental verification of the effectiveness of a cloud-oriented system of using information technologies in the educational space of a higher school

In the process of experimental research, we proved the necessity of using information technologies in the educational process of higher education institutions; the content of research concepts is revealed. A cloud-oriented system of using information technologies in the educational space of a higher school was built, the basis of which are specific principles of using information technologies, professionally oriented information technologies in the educational space of a higher school, and the main methods of professional training of future specialists, STEAM technologies, which made it possible to form future specialist's relevant professional competences.

In the research process, the levels and elements of the future competitive specialist's readiness to use information technologies were identified: the future specialist's own level of mastery of computerized technologies; the individual's ability to directly use information technologies in professional activities; the ability to improve one's professional level with the help of the Internet. The study allowed higher education students to use computer simulation programs to create educational complexes for self-education, which is the most effective form of using information technologies in education.

Graduates of higher education combined Simulink and Matlab programs, which made it possible to optimize systems, generate them, analyze them, and create a wide range of toolboxes. The Matlab graphics system contains high-level commands for three-dimensional and two-dimensional data visualization, animation, image processing, and graphing. The Partial Differential Equation (PDE) application is designed to solve problematic tasks. The Symbolic Math application made it possible to perform statistical calculations in the Matlab environment, and the System Identification package was included in the set of tools intended for the identification and evaluation of systems. Such programs are necessary during laboratory classes.

During the training of specialists, it was necessary to model processes using S-models. Virtual reality technology, which allowed students to model, project, visualize, and explore, was of great importance for quality education.

In order to check the effectiveness of the proposed cloud-oriented system of using information technologies in the educational space of a higher school, criteria (cognitive, motivational, reflective, operational and activity) of future readiness of specialists to use information technologies, as well as indicators of the specified criteria (recognition of value, formation of meta-subject ICT in young people) were developed – skill; when mastering innovative applications of information technologies, formation of readiness to overcome difficulties; knowledge of the essence, types of information technologies; knowledge of methods, forms of organization of information technologies; knowledge of the latest tools of information technologies; ability to apply various forms and methods of organizing the activities of specialists using information technologies ; the ability to select and master the newest tools of information technologies for work in the field; the ability to increase the level of readiness for the use of information technologies). The diagnostic apparatus for finding out the level of the indicated readiness for the application of a cloud-oriented system of using information technologies includes observation, questionnaires, surveys, analysis of the products of the respondents' activities – the results of the implementation of STEAM-developments, individual research tasks, etc.

The following components are distinguished in the structure of the indicated readiness: motivational-value, operational-active, cognitive, and reflective-evaluative.

The weighting coefficients of each of the criteria and indicators were determined to calculate the integrated value of the readiness level.

The analysis of integrated values showed that the implementation of the developed cloud-oriented system for the use of information technologies in the experimental groups had a significant impact on the level of readiness of the respondents to use information technologies.

The increase in the number of respondents with a high level of stated readiness to use information technologies was 34.8% among the respondents of the experimental group, and only 18.1% among the respondents of the control group.

The increase in the number of respondents with a sufficient level of readiness was 23.3% among the respondents of the experimental group, and only 12.3% among the respondents of the control group. We observe a decrease in the number of respondents with an average level of readiness by 24.0% in the experimental group, and only by 8.3% in the respondents of the control group;

We observe a decrease in the number of respondents with a low level of readiness detection by 34.2% in the experimental group and by 21.8% in the control group.

During our research, we implemented the achievements of Web 2.0 in the educational process.

During the experiment, all higher education students created blogs for professional work.

During the experiment, the majority of students of higher education changed their opinion about the need for continuous self-learning using information technologies. 49% of respondents decided that it is necessary for education and work, and 92% of respondents noted that the educational process is optimized with the help of Web 2.0 and the use of information technologies contributes to the introduction of innovative methods into the educational process of higher education.

The use of information technologies for education changed the opinion of respondents regarding the additional burden on them – at the beginning of the experiment, from 39% of respondents to 23% at the end of the experiment, and indicated the need to introduce information technologies in the educational process: the beginning of the experiment – 33%, the end of the experiment – 91% respondents.

After the introduction of the experiment, we received positive results for the use of higher education resources (88%) and distance communication services (67%) by students, which speaks of the systematic work of higher education institutions regarding the introduction of information technologies and elements of distance learning.

Experimental data were processed using the Pearson χ^2 criterion, which gave grounds for concluding that the proposed hypothesis is correct and the feasibility of introducing the developed and proposed cloud-oriented system for the use of information technologies in the educational space of a higher school.

The processing of experimental data by mathematical methods gave the basis for a conclusion about the expediency of introducing the developed and proposed cloud-oriented system of using information technologies in the educational space of a higher school.

CONCLUSIONS

In the process of experimental research, we proved the necessity of using information technologies in the educational process of higher education institutions; the content of research concepts is revealed. A cloud-oriented system of using information technologies in the educational space of a higher school was built, the basis of which are specific principles of using information technologies, professionally oriented information technologies in the educational space of a higher school, and the main methods of professional training of future specialists, STEAM technologies, which made it possible to form future specialists relevant professional competences.

Students of higher education in the research process combined Simulink and Matlab programs, which provided an opportunity to optimize systems, their generation, and analysis and to create a wide range of instrumental professional applications (toolboxes). The Matlab graphics system contains high-level commands for three-dimensional and two-dimensional data visualization, animation, image processing, and graphing. The Partial Differential Equation (PDE) application is designed to solve problematic tasks. The Symbolic Math application made it possible to perform statistical calculations in the Matlab environment, and the System Identification package was included in the set of tools intended for the identification and evaluation of systems. Such programs are necessary during laboratory classes.

During the training of specialists, it was necessary to model processes using S-models. Virtual reality technology, which allowed students to model, project, visualize, and explore, was of great importance for quality education.

The diagnostic apparatus for finding out the level of the indicated readiness for the application of a cloud-oriented system of using information technologies includes observation, questionnaires, surveys, analysis of the products of the respondents' activities – the results of the implementation of STEAM-developments, individual research tasks, etc.

Experimental data were processed using the Pearson $\chi 2$ criterion, which gave grounds for concluding that the hypothesis was correct and the feasibility of introducing the developed and proposed cloud-oriented system of using information technologies in the educational space of a higher school.

The processing of experimental data by mathematical methods gave the basis for a conclusion about the expediency of introducing the developed and proposed cloud-oriented system of using information technologies in the educational space of a higher school.

Further research will be aimed at STEAM technologies, which are necessary for high-quality training of specialists.

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