Training of future teachers of natural sciences for the use of information and communication technologies in their professional activities[78]

Підготовка майбутніх учителів природничих дисциплін до використання інформаційно-комунікаційних технологій в професійній діяльності

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Abstract

Today, an important aspect of future teachers training, in particular, natural sciences, is the usage of innovative technologies and approaches in the educational process of higher education institutions. The features of training future teachers of natural sciences using information and communication technologies are considered. The general global trends in the development of informatization of education are highlighted: expansion of the scope of use new information technologies.

The principles of using information and communication technologies in the educational process are highlighted: the principle of visibility; the principle of expediency; the principle of systematicity and consistency; the principle of strength of knowledge; the principle of accessibility; the principle of individualization; the principle of connecting

Анотація

Сьогодні важливим аспектом підготовки майбутніх учителів, зокрема, природничих дисциплін, є використання цифрових технологій і підходів у навчальному процесі вищих навчальних закладів. Розглянуто особливості підготовки майбутніх учителів природничих дисциплін з використанням цифрових технологій. Висвітлено загальносвітові тенденції розвитку інформатизації освіти: розширення сфери використання нових технологій. Розглянуто принципи використання інформаційно-комунікаційних технологій у навчальному процесі: принцип наочності; принцип доцільності; принцип системності та послідовності; принцип міцності знання; принцип доступності; принцип індивідуалізації; принцип зв'язку теорії з практикою; принцип мультимедійності;

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theory with practice; the principle of multimedia; the principle of interactivity. Online tools are highlighted to enable the use of innovative technologies for teaching future teachers of natural sciences. It is noted that in the educational system there are applications and information and communication technologies that widely used in the education system: word supercomputers, databases, demonstration programs, catalogue organization schemes, planners, graphic packages, etc.

Keywords: training, use of information and communication technologies, future teachers of natural sciences, professional activity, distance learning.

принцип інтерактивності. Висвітлено онлайн-інструменти, що дозволяють використовувати інноваційні технології для навчання майбутніх учителів природничих дисциплін. Зазначається, що в освітній системі є прикладні та інформаційні технології, які широко використовуються в системі освіти: текстові процесори, електронні таблиці, платформи розробки презентацій, системи керування базами даних, органайзери, графічні пакети тощо.

Ключові слова: навчання, застосування інформаційно-комунікаційних технологій, майбутні вчителі природничих дисциплін, професійна діяльність, дистанційне навчання.

Introduction

In the modern conditions of reforming the domestic education system, the problem of training a new generation of teachers capable of professional activity in the context of the transition of the world community to the information society is of particular importance. The great importance in the creation and effective functioning of an innovative educational environment at this stage is the introduction of recent information technologies into the educational development of higher education institutions, thereby ensuring the gradual transition of the learning process to a new, qualitative level (Makhometa et al., 2019).

The rapid growth of scientific knowledge that humanity has accumulated (every 2 years the total content of information increases 6-8 times), prompted the emergence of computer technology, the significance of which is obvious to each of us, especially in quarantine conditions. Therefore, in accordance with the evolutionary changes in the system of society, a generation of new children is coming, which is able to meet the challenges of the time. This requires a change in methodological approaches to teacher training, the formation of systematic pedagogical thinking (Stepaniuk, 2020).

Educators of the new generation must be able to competently choose and apply exactly those technologies that fully correspond to the content and goals of studying a specific discipline, contribute to the harmonious development of students, taking into account their individual characteristics. A modern teacher must not only be able to teach "his" subject, but also master information technologies and creatively apply them in a specific educational field.

In these conditions, the task of training is not just a teacher who knows information technologies, but a researcher, innovator and experimenter, a person capable of creative searches, a critical assessment of the historical pedagogical heritage, capable of adaptation in society and constant changes in technology and technology. It is necessary to prepare the teacher of natural disciplines for innovative activities at school, which includes in-depth training in the field of information technologies, readiness for innovative activities in the field of using information technologies, and readiness for student education in accordance with the requirements of modern society.

Modern education reforms with a focus on integration expand and complicate the tasks facing the system of training future teachers of natural sciences. They allow him to navigate freely in the new conditions of the information society.

Pedagogical practice needs scientifically based recommendations to overcome the spontaneous approach to the process of forming future science teachers' skills to implement information integration. Therefore, the higher pedagogical school faces another requirement today - the training of a teacher capable of conducting professional activities at a high level in the conditions of information technologies.

In connection with the above, there is a need to consider the future teachers training of natural sciences for the use of information and communication technologies in their professional activities. The article also shows which universal programs and information and

communication technologies are used in the education system. The priority measures for the implementation of the remote form of teacher counseling are shown.

Literature Review

Makhometa et al., (2019) outlined the problem of methodological future teachers training of natural and mathematical courses. One of the innovative educational technologies that contribute to refining the value of natural and mathematical education is the introduction of research training technology.

Gurevich et al., (2012) described the latest methods of implementing information and communication technologies, their creative self-realization. Attention is paid to innovative forms and methods of teaching, the use of interactive technologies, the information educational environment, and the organization of project training.

A. Hura (2018) defined the role and diversity of information technologies in the future teachers training of environmental sciences. The following information and communication technologies that are most often used in lectures, practical and laboratory classes are highlighted: electronic textbook; information system; electronic workshop; electronic task book; electronic system for assessing and controlling knowledge.

O. Vorobyova 's (2022) research is devoted to the actual problems of forming key digital and professional competencies of teachers, which ensure the implementation of pedagogical practice using digital technologies and tools to achieve new educational results.

Shchyrbul et al., (2022) show that «…the modernization of the educational sector requires globalization, democratization, and the transition to an information technology society».

Polishchuk et al., (2022) are revealed in the article that «…the purpose of education is to create an effective system using multimedia technologies that ensures the formation of highly qualified employees, implement educational policy as a priority function of the state».

Shunkov et al., (2022) was found that «…a promising area is the use of multimedia technology in educational activities to create a design of a virtual computer environment by means of digitizing audiovisual information».

Kotiash et al., (2022) substantiates that «…the need for widespread use of information and communication technologies as an important factor in accelerating scientific and technological progress, automation and intensification of production, creation of new high-performance technologies, improving planning and management».

Sutadji et al., (2021) pay their attentions «…on the analysis of differences in implementation of the assessment carried out, assignment techniques, assessment components, and post-assessment at the State University of Malang in two different fields of science, namely natural sciences and social sciences».

Kuzminskyi et al., (2021) considered the education of students in universities during distance learning, demonstrated the features of distance learning, highlighted the special features of distance learning in the preparation of students and in the introduction of these technologies into the educational process of the university. The article established that the improvement of pedagogical support during distance learning improves under the following conditions: the presence of students in digital education, taking into account the psychological needs of perception, memory, attention and age characteristics of students, their individual characteristics, the creation of a psychological benefit that dedicates the skill to communication by means of digital technologies.

The research of Teplytskyi et al., (2015) allowed us «…to determine the conditions of professional training of future teachers of natural and mathematical disciplines by means of computer modeling, to develop a structural and functional model of training, to select socio-constructivist forms of organization, methods and means of teaching computer modeling to future teachers of natural and mathematical disciplines».

The purpose. To identify new approaches to training future teachers of natural sciences through the use of information and communication technologies in professional activities.

Methodology

To achieve the purpose, we used methods that made it possible to comprehensively understand the subject, namely: theoretical (analysis of moral, educational, mental studios), which allowed us to substantiate the conceptual foundations of the work; informative and logical

method used for analysis, synthesis, systematization and generalization of scientific provisions; comparative historical analysis to compare the domestic and foreign content of methodological professional training of teachers in natural disciplines.

The methodological level shows the interrelationship of fundamental approaches to solving the problem of training future teachers of natural sciences to use information and communication technologies in professional activities.

In a number of methodological approaches, the advantage is the competence approach, which in synergistic interaction with systemic, person-oriented, activity, technological, contextual, reflexive and co-evolutionary-noospheric approaches, will ensure the effectiveness of their combined pedagogical influence on the formation of training of future teachers of natural sciences to use information- communication technologies in professional activity.

The methodological bases of intelligence are:

− deep philosophical and cultural provisions on the interaction of nature and man, which justify the idea of co-evolution of nature and sustainable development of society and the need to harmonize mutual influences in the system "nature - man - society";
− an epistemological concept that characterizes the main stages of the process of knowledge acquisition (sensation, perception, comprehension, understanding, generalization, consolidation, application) and shows the relationship of value, motivation and activity components;
− psychological-pedagogical foundations of updating the content (improvement of the educational process, improvement of the quality of training of specialists and entry of the national system of higher education into the European and world educational communities).

The article shows the methodical system of training future teachers of natural sciences, which reflects the system of goals, content, organizational forms, methods and means that provide professionally oriented training, aimed at mastering all components of professional competence and forming their readiness for the development of students' environmental knowledge.

Results and Discussion

Today, an important aspect of future teachers training, in particular, environmental sciences, is the use of innovative technologies and approaches in the educational process in universities. The problem of future teachers training using information and communication technologies is currently open and relevant. One of the priority areas for modernizing the professional training of future teachers of natural sciences in higher education institutions is the combination of traditional training with the introduction of innovations, information and communication technologies (Makhometa et a., 2019).

An important provision of the document, which has been included in all important UNESCO documents in recent years, is to assign information and communication technologies the role of technology. Therefore, information and communication technologies should be used to: provide opportunities for success for everyone, so as not to increase the difference in opportunities to get a quality education between the poorest and the richest. Moreover, to support models of effective development; so that in the dissemination of information and culture, some countries do not prevail over others, to reduce the monopoly of mass media; to ensure adequate participation of all countries and individuals in the construction and use of human information space.

The practice of information technologies requires the creation of a new educational paradigm. It is generally accepted that an education applicant must be an active participant in the educational process. By means of information and communication technologies, it is realistic to put this principle of didactics in the basis of the entire educational process at school (Shakotko, 2008).
General global tendencies in the change of informatization of education are: expansion of the scope of use of new information and communication technologies; transition from episodic to systematic use of information technologies in the study of educational subjects, courses; the emergence of fundamentally new learning tools, intellectualization of educational systems; extensive use of information technologies in extracurricular work, which helps to overcome the gap between educational and professional actions; creation of the foundations of information culture in mastering various specialties.

When studying biology and ecology, the following technologies should be used: project, information, group, game, modeling of the educational process at school. The use of information and communication technologies allows you to change the nature of students' educational and cognitive activities, activate independent work with various means – electronic textbooks, manuals, multimedia projector, systems for monitoring and evaluating knowledge, skills and abilities. Future teachers of natural sciences are interested in designing the learning cycle (goal formulation, selection of means of presenting material on a computer, search for interactive exercises and tasks. Diagnostic electronic testing systems facilitate the assessment and maintenance of rating records of academic achievements. It is possible to determine the individual characteristics and inclinations of students based on the designed and presented search information from the global internet. Since the presentation of educational material using computer technology (multimedia presentations, publications, and educational websites) is quite multifaceted and diverse, because everyone approaches the creation of didactic, visual, methodological works on paper or electronic media in their own way.

Let us highlight the principles of using information technologies in the educational development: the principle of visibility; the principle of expediency; the principle of systematicity and consistency; the principle of strength of knowledge; the principle of accessibility; the principle of individualization; the principle of connecting theory with practice; the principle of multimedia; the principle of interactivity.

Digital technologies are not just a carrier of relevant information, but also perform a specific function, clearly defined by the teacher, which is able to develop and accumulate knowledge of a particular specialty. Most often, the following information and communication technologies are used in lectures, practical and laboratory classes: an electronic textbook; an information and reference system; an electronic workshop; an electronic task book; an electronic system for assessing and controlling knowledge (Hura, 2018).

To teach future teachers of environmental sciences to use innovative technologies, you should use various online tools during a front-end survey. One of the modern online tools that is admired by educational applicants, regardless of their age, is Kahoot! This is an educational service that allows you to conduct interactive educational games: quizzes, discussions, surveys, etc. You can access it via the web browser or the Kahoot app! In Google Play or the App Store.

One more online facility that lets you to make cooperative exercises is LearningApps.org. This service is a constructor for developing many tasks in several subject parts for use both during classroom classes and in extracurricular activities.

The Learningapps app is a Web 2.0 application for supporting educational processes in various types of educational institutions. The Learningapps Constructor is designed to develop and store interactive tasks in various subject disciplines, with the help of which educational applicants can test and consolidate their knowledge in a playful way, which pays to the creation of their mental interest. The service offers many interactive exercises that have been developed for various forms of the educational process. Through the classes with the help of this service, you can not only activate the educational activities of applicants for higher education, but also demonstrate to future teachers how these exercises can be used in working with an interactive whiteboard, as well as how to use different workouts for pupils while performing independent work (Makhometa et al., 2019).

In the education system, universal Office applications and information and communication technologies are generally used: word processors, spreadsheets, presentation preparation programs, database management systems, organizers, graphic packages, etc.

Thanks to modern information technologies, such as e-mail, teleconferences or ICQ, communication between applicants in the educational process can be distributed in space and time. Therefore, for example, teachers and applicants for education can communicate with each other, being in different countries, at a convenient time for them, which is relevant in Ukraine during wartime.

Modern tools focused on Internet Technologies open up significant opportunities for visualizing educational materials and building interactive virtual laboratory workshops that are organically integrated into the educational process. Now the market of electronic educational resources is developing rapidly, teachers are offered a significant choice of pedagogical software tools. Every day, the possibilities of resources aimed at

improving the efficiency of the educational process and the quality of students' knowledge are growing.

They require widespread implementation of modeling and information technologies in the educational process, as well as the creation of appropriate electronic publications. At the present stage, there is a discrepancy between the ways of presenting educational material in electronic publications and modern educational theories. Most e-learning materials are created as static hypertext documents, which sometimes include Flash animations. At the same time, the educational process will be more effective if interactive, multimedia educational resources are used, which provide active teaching methods. This discrepancy arises because the process of creating and implementing an informational educational environment for active learning is a complex task that requires time and significant material costs.

It is justified and effective to use pedagogical software tools in the educational process, if they have a high level of interactivity, which ensures the dialogue of educational applicants with the computer, and this, in turn, occurs when cooperation is carried out between the educational applicant and the computer. The consequences of such cooperation are a high level of motivation to solve the tasks set by the participants of the studied processes.

Multimedia courses adapted to a particular specialty and aimed at forming knowledge, skills and abilities in a particular field of knowledge, profession based on the use of demonstration material, electronic textbooks, laboratory workshops, etc. are widely used.

Experience shows that the use of interactive multimedia lectures allows you to integrate a variety of information presentation environments, text, and dynamic graphics, audio and video materials that provide each applicant with the opportunity to become an active participant in the educational process.

The great importance for professionally oriented disciplines is the implementation of modeling using computers, as well as performing virtual laboratory work.

For this purpose, computer tools are used that allow you to create simulators, models, and laboratory work that cannot be performed in real conditions.

In the process of developing multimedia courses, it is important to solve one of the main didactic tasks of this subject area – modeling and the most general method of influencing objects of cognition. Modeling using computers allows you to demonstrate and investigate the basic properties of objects, phenomena that occur in various processes, etc. (Gurevich et al., 2012).

For the second year in a row, the entire world found itself in difficult economic and psychological conditions caused by the pandemic. The transition to online, distance or mixed learning has become an unexpected and quite serious challenge for all participants in the educational process: from teachers to students (Moskalyuk, 2021; Dibrova et al., 2021; Sovhira, Chyrva & Bahrii, 2018).

The role of the teacher changes a lot in this educational process. The teacher is entrusted with such functions as observing and evaluating the cognitive process, changing the studied course, helping the student in drawing up a personal academic plan, managing projects, etc.

Analyzing the advantages of distance education from the point of view of teacher-student communication, we reveal the following main features: self-education as the basis of distance learning, which involves the student's own motivation for his own studies, as well as a separate level of self-organization. One-on-one communication, similar to a one-on-one consultation. Many-to-many interaction means that simultaneous communication of many students is allowed, sharing experiences and impressions with each other.

Therefore, distance education has many prerogatives over traditional education: progressive educational resources, availability of information keys, individualization of education, comfortable consultation procedure, democratic relations between student and teacher, practical schedule and place of activity (Kuzminsky et al., 2021; Volek, 2018; Bilyk et al., 2021).

Distance or mixed learning encourages and promotes the use of technologies, namely working with email, websites, platforms, and courses, communication via Viber, forums, chats, conferences and webinars. Prometheus, TeachHub, EdEra, and vseosvita.ua distance courses are very popular, which are focused on obtaining theoretical knowledge and practical skills in a short time. The Padlet, Classroom, Moodle, and Zoom video conferencing platforms are the most well known that are great for both

teachers and students. The e-Bug system is quite common, which is a free educational resource for use in the educational process and at home. Its purpose is to make training interesting and provide information about microorganisms, the spread, prevention and treatment of infectious diseases, etc. The resource contains lesson plans, worksheets, animations, demo experiments, presentations, online games, visualizations, and materials that will make learning at home easier. Mind Meister software helps you create thought maps and allows users to visualize their thoughts in the cloud using cloud storage. The program is easy to use and allows you to distribute changes in the form of maps in real time to all users and on all devices. Mind Meister offers a number of features that allow users to brainstorm online, plan projects, develop business strategies, create large presentations, and more.

Easel.ly, Visual.ly, Canva.com, Infogr.am, Piktochart.com services for creating online infographics. These platforms are interesting and easy to use, and have significant support for templates with accessible visual effects. The important thing is that the services are free and allow users to create graphics, presentations, posters, and so on. Very original and new is the use of 3D animal models in Google. Using your smartphone or laptop, you can view models of tiger, green turtle, pony and many other animals, which makes learning fun for both children and adults.

The Moza Map and Moza Book resources will help you diversify your training tools with illustrations, animations, and presentations, as well as applications that will help you conduct experiments and learn educational material more easily. In the process of studying human anatomy, collections of 3D atlases and the 3D Human anatomy resource will help which contain the best mobile applications available for smartphones, tablets and computers and are aimed at learning new techniques. The resources of Science in school, BiomeViewer (global ecosystem research), BioNetwork (virtual microscope), Teach Genenics (genetic research) and Sheppard Software (free educational games) will help to make learning fun, interactive and more memorable.

Another educational site that features videos and free online games, among other activities, is National Geographic Kids. The site is focused on studying plants and animals, but you can also virtually visit different countries, learn interesting facts, participate in quizzes, and post comments and photos.

Therefore, a prerequisite for the training of a modern teacher of natural sciences is familiarization with the latest discoveries of Science, and the Internet is a unique tool for solving many educational problems, improving the efficiency and level of training in general (Moskalyuk, 2021; Nurmukhanbetova et al., 2019).

Skype helps you communicate with a group of educational applicants. It is advisable to use it in training and afford educational material to a broader variety of education applicants, taking a computer linked to the Internet, so that education applicants who are not at school can use Skype to study at all, in actual time.

Online tool Padlet designed for creating and filling the content of a virtual whiteboard (space) with the ability to edit together. It is necessary to use the Padlet board for organizing group work of educational applicants during brainstorming, generalization and systematization of knowledge, reflection; for placing educational material or tasks for its search; as a place for placing ideas for projects and discussing them; as a tool for forming combined actions of educational applicants during the lesson and outside it.

The Trello online tool is also a virtual whiteboard, which is a good helper for teachers in working on joint online projects together with educational applicants. Using this tool, you can distribute tasks by type, and applicants for education, in the course of work, see its results (what they have done, what needs to be completed). Therefore, applicants for education learn to effectively organize their work in virtual mode understand the essence of teamwork. This is a useful visual tool in the work of a teacher.

QR codes allow you to attract educational applicants to study, organize game and research activities of educational applicants, organize QR quests, and much more.

Online training materials help to further motivate applicants for education, diversify classes and make them more modern. Most of them can be used on the mobile devices of educational applicants, and they contain libraries of ready-made exercises. For example, in the classroom, you can offer educational applicants LearningApps – an online feedback application in which educational applicants determine how well they have mastered the educational material, what questions are unclear. The service is based on working with templates: from working with

maps to solving crosswords and creating knowledge maps. Wordart.com is a web service for visualizing and creating a word cloud. Word clouds can be used to visualize natural terminology on a particular topic in a visual way. This helps you quickly remember information.

Powtoon.com and SparkolVideoScribe are web services for forming active videos, communicating infographics, presentations, and video creaming. The finished video can be available on YouTube or Vimeo, as well as uploaded as Ppt, Pdf formats, or embedded on your website/blog using HTML code. With the support of scribing, you can fast appeal the attention of listeners, provide them with extra material and highlight the chief facts of the report.

Keep in mind that quizzes and tests help students get interested in the topic, facilitate its perception, assimilation, and test their knowledge. Google Forms is a resource that has a large number of design templates, which allows you to create forms for classes on any topic. Online test Pad is a website that allows you to work with constructors for creating tests, crosswords, surveys, and dialog simulators free. A unique tool for organizing group work and reflection is MindMeister. This service allows you to create intelligence maps, the use of which in the educational process provides feedback, in particular, through final and formative assessment.

Effective in the professional training of future teachers of natural sciences and in teaching students is the use of online tools using gadgets. For example, Nearpod is an online tool that allows teachers to create individual tasks and track their progress using mobile devices. A special feature of this service is that users can connect to Nearpod 3D and Nearpod VR. The use of the above-mentioned web services in practical activities provides an opportunity to intensify the learning process, increase the level of professional training of future teachers of natural sciences, and contributes to the development of end-to-end skills of students (Vorobyova, 2022; Plakhotnik et al., 2022).

We would like to emphasize that teachers should be well-versed in managing a wide range of information resources and managing the reform of the educational sector in relation to the standards of the European educational space. This process is very long, and Ukraine is doing everything possible to go in this direction. Authorities are creating regulations for distance education, expanding blended learning approaches, and working to increase the number of schools with Internet connections and access to digital devices and equipment.

This work aims to implement sustainable and flexible approaches in future educational activities aimed at preserving the continuity of learning through measures to expand digitalization of higher education (Kuzminsky et al., 2021).

The involvement of network information and communication technologies in the educational process of object-oriented modeling provides an opportunity to organize remote consultations in the form of electronic correspondence, chat or forums, audio and video conferences, etc. Their implementation allows any student to receive advice at a convenient time; to provide publicity to the consulting process through posting questions and answers on a specialized forum; as a result, to increase the effectiveness of consulting by avoiding the same type of questions. In addition, to accumulate a bank of standard questions and answers available to different generations of students; to promptly inform students about the tasks of control and practical works, make announcements, etc. Additional advantages of this form of consultation are its transparency, modernity and compliance with the requirements of the Bologna Process.

To implement the remote form of counseling, the following priority measures are necessary: 1) creation and placement on the Internet of a consultation point in the form of a forum with sections conducted by individual teachers; 2) development and approval of regulations on remote counseling of students; 3) providing students and teachers with internet tools for conducting remote counseling (Teplytskyi et al., 2015).

Conclusions

In connection with an important aspect of future teachers training of environmental sciences, it is the use of innovative technologies and approaches in the educational process of higher education institutions. Therefore, we have considered the specifics of training future teachers of natural sciences using information and communication technologies. The general global trends in the development of informatization of education are highlighted; the principles of using information technologies in the educational process and online tools for the

possibility of using innovative technologies for teaching future teachers of natural sciences are highlighted. The advantages of distance learning in comparison with traditional training are shown. The most popular distance courses that are focused on obtaining theoretical knowledge and practical skills in a short time are analyzed.

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