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USE OF GEOINFORMATION TECHNOLOGIES IN DISTANCE LEARNING OF FUTURE SPECIALISTS IN GEOGRAPHY

Abstract. Geoinformation technologies are an important element of professional education for future geographers and are widely used in their training program, at the same time geoinformation technologies depend on the participants' technical support in the educational process, both in full-time education and distance learning. The article examines the specifics of the application of geoinformation technologies in the organization of distance learning on the example of certain disciplines of the curriculum of future geography specialists.

The article identifies the advantages and disadvantages of distance learning on the example of the disciplines "Fundamentals of Geoinformatics" and "Cartography and GIS" studied by the students of the Department of Physical Geography and Efficient Environmental Management of the Faculty of Geography at Uzhhorod National University. The absolute advantages of this studying format for teachers are the ability to freely choose the necessary materials, academic mobility and a fundamentally new educational space. Students have the opportunity to master new disciplines in more comfortable conditions for them and in compliance with the principles of equality. At the same time, distance learning involves a wide application of an individual approach to each student, taking into account, in particular, the hardware and software necessary to work with GIS technologies.

The main disadvantages of distance learning of the academic disciplines "Fundamentals of Geoinformatics" and "Cartography and GIS" are considered. The most problematic issue for all participants of the educational process is the technical and software support at home. The process of providing students with a licensed software product taking into account different levels of hardware (personal computers, laptops, tablets) is also resource-intensive. The lack of a social environment for students is another disadvantage of distance education.

Ways and means of overcoming the indicated shortcomings of distance learning of the disciplines "Fundamentals of Geoinformatics" and "Cartography and GIS" using the geographic information system ArcGIS are proposed. While forming the structure of the educational process it is necessary to solve the problem of hardware and software, form the information content of the courses and provide access to it. Google services and the Moodle platform can play an important role here.

Keywords: distance learning; geoinformation system ArcGIS; academic discipline; specialists in geography.

1. INTRODUCTION

Problem statement. The rapid development of computer technologies and their introduction into the educational process allow students to achieve better results in mastering new material, acquisition of practical skills and effective implementation of independent work. Due to the requirements of the Law of Ukraine “On Scientific and Scientific-Technical Activities” [1], the Law of Ukraine “On priority areas of innovative activity in Ukraine” [2], as well as the Concept of the development of distance education in Ukraine [3], we can testify to an increase in the effectiveness of the use of computer technologies in the educational process in general and geoinformation technologies in the training of future specialists in geography in particular. The reform of education and the wide application of the results of scientific and technological progress together with the activation of students’ cognitive activity, even in the conditions of distance learning, ultimately give a positive result.

The changes that have taken place over the past few years have made it necessary to find ways to adapt to the new realities of life and work. The outbreak of the COVID-19 coronavirus pandemic in the world led to unexpected and wide repercussions and addressing these challenges requires new approaches, means and methods, in particular, in the work of higher educational institutions of Ukraine. As a result, pedagogical activity gradually changes the format from full-time education to mixed (distance and full-time) education, and at a certain point becomes exclusively distance. The consequence of such changes is the need to find new methods and ways to maintain the educational process using remote technologies.

Uzhhorod National University, Ukraine, is no exception. Since 2020, students’ education is mainly conducted remotely, with the exception of individual laboratory (practical) classes and practical training. The need for a sudden change in the form and methods of teaching students led to a number of organizational, technical, methodological and other problems that had to be solved as soon as possible. At the same time, the need to introduce new methods and means of teaching led to the impetus to enhance teachers’ professional development, improve the existing skills and abilities and acquire new ones. An example can be the training of future specialists in geography, which is carried out by teachers of the Department of Physical Geography and Efficient Environmental Management at the Faculty of Geography of Uzhhorod National University. Since 2020, studies at the university are conducted in a distance mode using modern information technologies.

Due to the detailed coverage of the strengths and weaknesses of the application of geoinformation technologies in the conditions of distance learning for the study of specific disciplines of the geographical field of sciences, we can predict the level of professional competences of Geography students in the future. Thus, the results of the study can be used in the educational process planning and creation of the educational environment for the training of geography specialists in the conditions of new realities (the COVID-19 pandemic, the Russian-Ukrainian war).

Analysis of recent studies and publications. The analysis of the achievements of domestic and foreign scientists shows the relevance of the chosen research topic. Separate theoretical and methodological foundations of the formation of the distance learning process are considered in the works of D. Kulich, A. Yankovych [4], O. O. Romanovskiy, Yu. Yu. Romanovska, N. M. Chaplynska, and S. A. Danylov [5]. I. Prokopenko and S. Berezhna analyzed the problems faced by higher educational institutions of Ukraine during the COVID-19 pandemic [6]. An overview of the possibilities of using mobile technologies in education is given in the work of V. Miziuk, M. Dmytriieva [7], and ways of developing digital competence

were considered by V. V. Oliinyk, N. I. Hushchyna, L. H. Kondratova, S. P. Kasian [8]. Y. Krylova-Grek and M. P. Shyshkina considered the problems of distance education in Ukraine and ways of solving them in sufficient detail [9]. Features of the use of information technologies and digital learning tools are given in the works of O. A. Dubaseniuk and O. M. Kovalenko [10], [11]. The role of geoinformation technologies and geographic systems, in particular for the formation of subject competences in training professionals in geography, was analyzed by V. V. Leta, M. M. Karabiniuk, R. S. Molikeyvych, I. V. Kholoshyn, O. V. Bondarenko, M. DeMers, T. Chou, M. Yeh, Y. Lai [12], [13], [14], [15], [16]. The directions of using computer technologies, the analysis of problems and ways to solve them, as well as the consideration of individual programs and services are presented in the works of O. V. Bondarenko and others [17], N. S. Babieva and others [18], R. H. Audet, J. Paris [19]. The theoretical and methodological foundations of distance learning, ways of its implementation, prospects and problems that arose during the COVID-19 pandemic are reflected in the works of many foreign scientists, among whom we can highlight H. Karnatak [20], R. Delling [21], G. Rumble [22], M. Simonson [23], I. Ivanova [24], M. Segbenya [25], I. Pylypenko [26] and others [27].

The aim of the article is to reveal the specifics and problematic aspects of the use of GIS technologies, using the ArcGIS software package as an example, in training future specialists in geography at the Faculty of Geography of Uzhhorod National University. Possible ways of solving problems and difficulties that arose in the conditions of students' distance learning with the aim of effective changes in the system of study of the academic disciplines "Fundamentals of Geoinformatics" and "Cartography and GIS" were also considered.

2. THEORETICAL BASICS AND RESEARCH METHODOLOGY

GIS technologies are a system of tools, measures and methods for creating geographic information systems (GIS), which include manufacturers, consumers and specialists in the field of working with geospatial data. Today, there is a large number of commercial and open GIS, which are widely used in scientific and educational activities of higher educational institutions of various accreditation levels. Thus, the following GIS are often used when training specialists in natural sciences: SAGA GIS, GRASS GIS, QGIS, ArcGIS, MapInfo and others. The choice of a geographic information system depends on the direction of its use, practical goals and technical capabilities. Specialists in geography must possess a wide range of knowledge, abilities and skills in working with geospatial data, and therefore the Faculty of Geography of Uzhhorod National University gives preference to the ArcGIS software package, which includes almost the largest set of tools for processing, analyzing and outputting spatially oriented data.

ArcGIS is a software package that gives the possibility to collect, input, process, analyze and output geographic information [28]. The ArcGIS platform is a leader in the geographic information systems market and is available to users of desktop computers, mobile devices (tablets, phones), and also provides online access to its resources, which is definitely an advantage in distance learning. The software package includes applications ArcCatalog, ArcMap, ArcGlobe, ArcScene and a number of others. The main application of the ArcGIS software package is the ArcMap application, which is designed for the creation, editing, processing, analysis and output of geospatial data in the form of cartographic works (electronic maps, map charts, series of thematic maps, three-dimensional images, etc.). Creation, editing and visualization of three-dimensional images of the Earth's surface is performed using the ArcScene application. The creation and management of spatially coordinated data is provided by ArcCatalog, a file manager for creating, copying, and deleting files used in ArcGIS.

ArcGIS Pro package is available for more advanced users, and ArcGIS Online platform (for PC users) and mobile applications ArcGIS Explorer, ArcGIS Field Maps, ArcGIS Earth and others are available for people with limited technical capabilities (Fig. 1-2). A wide range of software from the ArcGIS family provides the opportunity to select the software product that is best suited for educational purposes and users' (students') technical support.

The "Geography" educational program, which trains future specialists in geography, includes in its curriculum courses which study the possibilities of using GIS technologies in the work of a geographer (practitioner) and geography teacher. These include the courses "Fundamentals of Geoinformatics" and "Cartography and GIS", which students of the Faculty of Geography of Uzhhorod National University study consecutively in the first and second years, respectively.



Figure 1

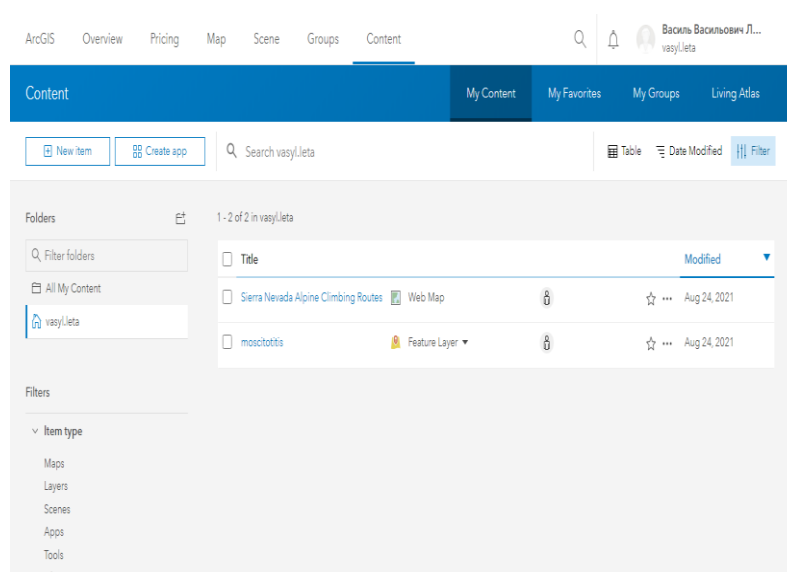


Figure 2

Fig. 1. ArcGIS Explorer mobile application interface. Fig 2. ArcGIS Online service interface.

Within the course "Fundamentals of Geoinformatics" students study the theoretical foundations of geoinformatics and master the skills in working on personal computers with various databases and database management systems, modern office systems and GIS, in particular, get acquainted with the basic aspects of working in the ArcGIS software environment. As a result of studying the discipline, students acquire the following knowledge, skills and abilities:

- mastering the conceptual and terminological apparatus of geoinformation technologies;
- acquisition of basic skills in working with modern geo-information systems using ESRI software as an example;
- study of analysis methods and spatially coordinated data visualization by means of GIS;
- acquiring skills in the practical use of geo-information technologies in further professional activities.

The discipline "Cartography and GIS" is also important for the study of geographic information systems. Within the course, students have the opportunity to familiarize themselves with the properties and features of geographic maps and other cartographic works, while at the same time mastering new and improving previously acquired skills in creating and editing

digital maps using the ArcGIS geographic information system. The materials of the course deepen and improve students' previously formed cartographic knowledge, abilities and skills of working in the environment of geoinformation technologies. The discipline "Cartography and GIS" is a logical continuation of "Fundamentals of geoinformatics" and allows students to familiarize themselves more closely with the subject of research, methods, tools and relevant technologies for obtaining, processing, analyzing and outputting geographic information using the ArcGIS environment.

Successful study of the discipline "Cartography and GIS" guarantees to future specialists in geography:

- thorough knowledge of the theoretical and methodological foundations of cartography and geo-information systems;
- the ability to use the cartographic method of research and geo-informational modeling in professional activity;
- skills in using cartographic works for the analysis of a territory, objects of the natural environment, phenomena and processes in the geographical envelope;
- thematic mapping skills;
- the ability to analyze and reproduce on the map cause-and-effect relationships between phenomena and processes within individual geosystems.

Working with database management systems of spatially coordinated information using GIS technologies makes it possible to present the results of work online in the form of maps, geoinformation systems or geoportals. Therefore, the output of electronic maps using ArcGIS contributes to a better presentation and understanding of spatial data. The ability to work with GIS technologies expands the circle of consumers from specific applied industries (engineering geology, cadaster, topography) to the provision of services, management, administration, as well as educational activities [12]. In the educational sphere, the main users of geographic information, in particular in the form of digital (electronic) maps, are students, teachers, staff of higher education institutions. This, in turn, makes the study of GIS technologies an important integral part of the educational process, in particular, in the "Geography" educational program. Successful study in this program enables students to acquire the following subject competencies:

- the ability to understand the essence of the relationship between a person and their natural environment, to understand and explain the strategy of sustainable development of humankind.
- the ability to appropriately and critically use geographical concepts, paradigms, theories, ideas, concepts, principles to explain phenomena and processes at different spatial levels (global, regional, state, local) by written, oral and visual means.
- the ability to apply basic knowledge of natural and social sciences in education and professional activities when studying the Earth (world), continents and oceans, Ukraine
- the ability to understand and explain the features of natural components and objects in the spheres of the geographical envelope, relationships in landscapes
- the ability to explain the patterns of territorial organization of social production, spatial processes and forms of organization of people's lives
- the ability to establish the role and place of Ukraine in the modern world in the context of geographical factors of its development, to analyze and explain the specific features of the geospatial organization of nature, population and economy of Ukraine and Transcarpathian region in particular [29], [30].

To achieve the goal of our research, the following methods were used: analysis of syllabi of the disciplines "Fundamentals of Geoinformatics" [29] and "Cartography and GIS" [30] for students of specialty 014.07 "Secondary education. Geography" of the Faculty of Geography

of Uzhhorod National University; selection and analysis of available sources of information (textbooks, geoportals, cartographic works, etc.); systematization of our own experience of learning the basics of mapping; generalization of materials in the form of methodological recommendations.

3. RESULTS OF THE STUDY

General provisions. The distance form of education involves the teacher's use of certain technological means and tools for indirect (online) communication with the student. Such means include communication lines (internet connection), personal computers (tablets, smartphones), software, audio and visual communication systems. The totality of these means is information and communication technologies (ICT), which are an important link in the model of the distance learning process.

ICT provides two-way communication between the teacher and the student, which is a determining factor in the implementation of the educational process under the conditions of COVID-19 pandemic and the war on the territory of Ukraine. The absence of at least one component of ICT makes it impossible for students to study the course to the full extent and master all the necessary knowledge and practical skills. As a result, the academic level of knowledge reduces, especially if the problem of hardware and software is not solved during the period of studying related courses.

Important conditions for studying the "Fundamentals of Geoinformatics" and "Cartography and GIS" courses are the use of appropriate equipment (personal computers, laptops, tablets) and software by the teacher and students. Today, there is an urgent need to meet the needs of all participants in the educational process in terms of equipment, licensed software products (ArcGIS software package 10.4.1 or a newer version) and access to the Moodle e-learning system. Ensuring a stable Internet connection and setting up an audio and video communication channel remains an equally important task. The educational process at Uzhhorod National University is mixed and distance learning is carried out using Google services, in particular such applications as Gmail (E-mail), Drive, Chat, Meet (Meeting) and others.

Google Meet is a free video calling application developed by Google in 2017. The Meet application is synchronized with other company services (Calendar, Drive, Mail) in case a single account is used. Accounts using the uzhnu.edu.ua domain have been created at Uzhhorod National University to ensure proper learning conditions and unify the credentials of all participants of the educational process.

The Google Meet service is intuitively easy to use, at the same time it allows you to use both a personal computer and a mobile device for an online meeting, create a virtual whiteboard for notes during the conference, make a screen presentation, chat with meeting/conference participants, make a video recording of a meeting/conference, etc.

The study of the discipline "Fundamentals of Geoinformatics" by the students of the Department of Physical Geography and Efficient Environmental Management of the Faculty of Geography of Uzhhorod National University involves obtaining a basic level of knowledge and practical skills in working in the environment of geoinformation technologies using the ArcGIS software package 10.4.1 version as an example. When studying the discipline "Cartography and GIS" students deepen the previously acquired theoretical knowledge and practical skills of working with the ArcGIS software package. In particular, the theoretical and methodological foundations of working with GIS from the ESRI company are mastered in the first year, while the second-year students meaningfully deepen the following skills and abilities:

- the ability to work in the ArcMap application with tools (ArcToolbox), which is used to vectorize geospatial data and build vector map layers;

- skills of working with data in the form of tables, implemented to analyze data, establish relationships and display selected objects (parameters);
- creating a digital model of the relief based on previously processed raster data (Fig. 3);
- classifying map objects (mathematical basis, relief, hydrology, vegetation, settlements, etc.);
- compiling thematic maps on the basis of previously created databases of spatially coordinated data;
- creating cartographic layouts and exporting (downloading) finished cartographic works.

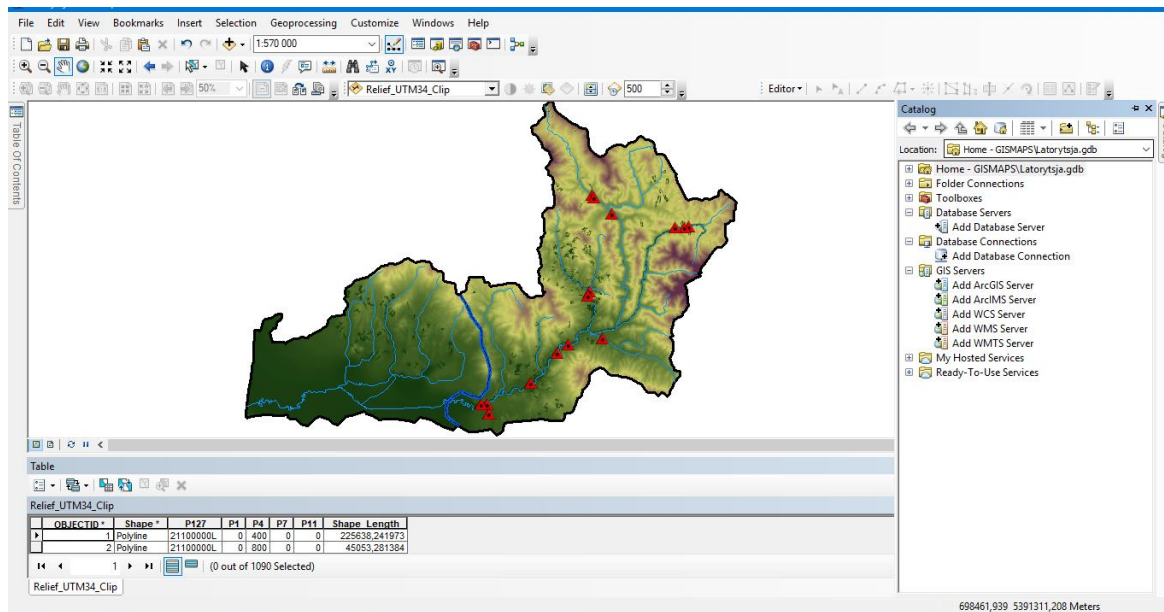


Fig. 3. ArcMap 10.4.1 program interface (example of creating a digital terrain model)

The role of the teacher in the educational process of the distance format is significantly expanded due to the constant need to form and update its structure. At the same time, there is a need for teachers to improve their own abilities and skills, improve their qualifications and use new methods and online learning technologies. Using the example of studying the disciplines “Fundamentals of Geoinformatics” and “Cartography and GIS” we can name a number of advantages of the distance format of the educational process.

For the teacher:

- the possibility to choose the necessary educational materials in electronic format, in particular in the form of electronic libraries, data banks on the Internet, educational portals, geoportals, etc.;
- the ability to freely plan the educational process within the study of individual disciplines;
- academic mobility – choosing and changing the structure of the academic discipline and the location of classes (outside or inside the university campus);
- presentation of course materials using the latest information and geo-information technologies;
- quick adaptation to new conditions and challenges of the educational process;
- a fundamentally new educational space;
- multimedia access to educational information from anywhere in the world at any time.

For students:

- equality of all students in obtaining the content of an academic discipline;

- the opportunity to study regardless of the student’s location, state of health and financial security;
- lack of communication barriers among students;
- self-organization, stimulation of self-development and self-education;
- comfortable conditions and optimal learning rates.

The advantages of distance learning provide more space and opportunities to creatively shape the structure and teaching methods of a particular academic discipline, increase the efficiency of both the presentation and assimilation of materials and the acquisition of subject and professional competencies, and contribute to the digitalization of the educational process.

At the same time, distance education has a number of disadvantages and problems. In particular, when teaching the disciplines “Fundamentals of Geoinformatics” and “Cartography and GIS”, teachers may encounter the following:

- insufficient level of technical support;
- lack of licensed ArcGIS software products in students’ homes;
- low rates of preparation and organization of the educational process;
- difficulties in preparing and distributing educational material in the discipline;
- increased volume of individual work with students;
- increased workload of teachers.

Students may have such difficulties as:

- insufficient level or lack of hardware (PCs, laptops, tablets);
- difficulties associated with obtaining and installing licensed ArcGIS software products;
- low level of preparation for independent study and learning of a significant part of the course;
- physical stress, in particular on eyes;
- lack of socialization.

Taking into account the modern requirements for education for a university degree, as well as our own pedagogical experience, in particular in the teaching of the above-mentioned disciplines, including in the distance form, we consider it necessary to outline the main directions and measures that will contribute to solving the problems of the use of geoinformation technologies in the training of future geography specialists. The most important include:

- provision of necessary hardware (PCs, laptops, tablets) and software packages (ArcGIS) to all participants of the educational process;
- ensuring equal access of all students to the information base of the course;
- use of educational platforms, in particular ESRI, for the purpose of conducting trainings for teachers of “Fundamentals of Geoinformatics” and “Cartography and GIS”;
- use of ArcGIS Online resources of the ESRI platform as an alternative to traditional laboratory classes (in case of appropriate technical support and software);
- the use of Google services (Drive, Classroom, Forms, Chat, etc.) as a platform with free access for all participants of the educational process in order to solve problems that arise during training and the formation of a new structure;
- use of the Moodle platform for information filling and knowledge verification (testing);
- changing the structure and evaluation criteria taking into account the software and technical support of students;
- exchange of experience with Ukrainian and foreign colleagues regarding tools for successful formation of distance learning structure of the discipline;

- constant improvement of teachers' qualifications;
- use of new resources (geoportals) and platforms, taking into account the provision of students with personal information equipment;
- development of distance learning courses in “Fundamentals of Geoinformatics” and “Cartography and GIS”.

The correct application of geoinformation technologies in the conditions of distance learning of the disciplines “Fundamentals of Geoinformatics” and “Cartography and GIS” makes it possible to count on the following main learning outcomes:

- knowledge of the subject area, scope of application, GIS hardware and software;
- the ability to receive, store and visualize geospatial information using GIS;
- implementation of vectorization of raster geodata;
- creation of a digital model of the relief of the territory;
- application of GIS technologies for the analysis of natural conditions of the territory, phenomena and processes, as well as anthropogenic factors of influence within individual geosystems;
- mastery of thematic mapping skills;
- the ability to use the cartographic method of research and geoinformation modeling in the practical activities of a geography specialist.

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The use of geoinformation technologies and systems in remote teaching of the disciplines “Fundamentals of Geoinformatics” and “Cartography and GIS” for future geography specialists at Uzhhorod National University gives a possibility to define all the positive and negative features of modern distance learning. At the same time, the change in the form of education promotes progress in professional education due to the widespread introduction of computer systems and geo-information technologies into the education process.

The use of the ArcGIS software during the teaching of the academic disciplines “Fundamentals of Geoinformatics” and “Cartography and GIS” allowed us to identify the weaknesses of the distance learning method, and also made it possible to optimize the curriculums in order to improve students' acquisition of new practical skills for working with GIS technologies. The use of ArcGIS from the ESRI company gives the possibility to single out a number of advantages in studying GIS technologies during distance education. It is associated with a wide range of applications and software resources that are able to provide the educational process for its participants with different hardware.

The results obtained at the first stages of the research were used in the 2022-2023 academic year in the conditions of educational environment changes as a result of the Russian armed aggression against Ukraine. Studying the process of training future geography specialists in the conditions of distance learning makes it possible to make structural changes in the relevant educational components in order to optimize and improve them.

Further monitoring of the current situation in higher education using the example of the Uzhhorod National University will allow a better understanding of problematic points and shortcomings in the structure of the educational process, as well as help to develop effective measures for its optimization.

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ВИКОРИСТАННЯ ГЕОІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ У ДИСТАНЦІЙНОМУ НАВЧАННІ МАЙБУТНІХ ФАХІВЦІВ З ГЕОГРАФІЇ

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Анотація. Геоінформаційні технології, що широко використовуються в навчальній програмі підготовки майбутніх географів, є важливим елементом їх професійної освіти, водночас їх використання залежить від матеріально-технічного забезпечення всіх учасників навчального процесу як за умов очного, так і дистанційного навчання. У статті розглянуто особливості застосування геоінформаційних технологій при організації дистанційної форми навчання на прикладі окремих дисциплін навчального плану майбутніх фахівців з географії.

У статті визначено переваги та недоліки дистанційної форми навчання на прикладі вивчення дисциплін «Основи геоінформатики» та «Картографія і ГІС» студентами кафедри фізичної географії та раціонального природокористування географічного факультету Ужгородського національного університету. Для викладачів безумовними перевагами такого формату є можливість вільно обирати необхідні матеріали, академічна мобільність та принципово новий освітній простір. Студенти ж мають можливість опанувати нові дисципліни в більш комфортних для них умовах і з дотриманням принципів рівності. Водночас дистанційне навчання передбачає широке застосування індивідуального підходу до кожного студента, враховуючи, зокрема, його апаратне та програмне забезпечення, необхідне для роботи з ГІС-технологіями.

Розглянуто основні недоліки дистанційної форми опанування дисциплін «Основи геоінформатики» та «Картографія і ГІС». Відтак найбільш проблемним є питання технічного та програмного забезпечення всіх учасників навчального процесу в умовах надомної роботи. Ресурсомістким є також процес забезпечення студентів ліцензійним програмним продуктом з урахуванням різного рівня апаратного забезпечення (персональними комп'ютерами, ноутбуками, планшетами). Також серед недоліків дистанційної форми навчання є відсутність соціального середовища студентів.

Запропоновано шляхи та засоби подолання вказаних недоліків дистанційного вивчення дисциплін «Основи геоінформатики» та «Картографія і ГІС» з використанням географічної інформаційної системи ArcGIS. Важливо на перших етапах формування структури навчального процесу вирішити проблему апаратного та програмного забезпечення, рівного доступу до інформаційного наповнення курсів, зокрема за допомогою сервісів Google та еплатформи Moodle.

Ключові слова: дистанційне навчання; геоінформаційна система ArcGIS; навчальна дисципліна; фахівці з географії.





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