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PECULIARITIES OF USING GEOINFORMATION SYSTEMS IN TRAINING OF FUTURE GEOGRAPHY SPECIALISTS IN HIGHER EDUCATION INSTITUTIONS

The article analyzes the peculiarities of using geoinformation systems in the educational process in higher education institutions and substantiates the need to study them in the training of a bachelor of geography (specialty 106 Geography). The connection of geoinformation systems (GIS) with other disciplines has been established. The topics of pre-geoinformation disciplines mastering of which will help students to acquire GIS technology without hindrance are described. The market of modern GIS packages, the use of which will help future specialists in geography to acquire GIS technology is analyzed.

The classification of software products (GIS package ArcGIS, MapInfo Professional, «Panorama 1») («Map 2011»), «Digitals», GeoDraw (Geograf), AutoCad Map 3D, SAGA GIS, GRASS GIS, ILWIS, MapWindow GIS), indicating functionality and tools of GIS packages is given. The possibilities of open programs are also presented; they can be used in the educational process (PhotoFiltre (mapping), XnView (viewing), Picasa (adding geotagging with which you can specify the capture area of any photo, using Google Earth and Google maps), Quantum GIS (can be used as the main platform for teaching students how to implement GIS and how to create the highest quality maps), Google Earth network services (electronic globe), ArcGIS Online (used to manage and share maps and geographic information), Golden SoftWare (Surfer) (universal mapping software that runs on Microsoft Windows and is used to quickly and accurately erase map surfaces and convert the provided data into contour, relief or post maps, three-dimensional surfaces, 3D frames or vector graphics).

The main models of data presentation, due to which the work of GIS can be realized, are considered. The main advantages and disadvantages of using these models are indicated. The main competencies that future geographers should acquire during the study of the discipline «Geographic Information Systems and Databases» are identified, which will give foundations for the formation of a sufficient level of a competitive geography specialist.

Keywords: GIS-technology, GIS-packages, DBMS, bachelor of geography, geographical data.

Олена Король, Олеся Корнус, Анатолій Корнус. ОСОБЛИВОСТІ ВИКОРИСТАННЯ ГЕОІНФОРМАЦІЙНИХ СИСТЕМ У ПІДГОТОВЦІ МАЙБУТНІХ ФАХІВЦІВ ГЕОГРАФІЇ В ЗАКЛАДАХ ВИЩОЇ ОСВІТИ

У статті проаналізовано особливості використання геоінформаційних систем в освітньому процесі в закладах вищої освіти та обгрунтовано необхідність їх вивчення у підготовці бакалавра географії (спеціальність 106 Географія). Встановлено зв'язок геоінформаційних систем з іншими навчальними дисциплінами. Описано теми догеоінформаційних дисциплін, опанування якими допоможе студентам безперешкодно оволодіти ГІС-технологію. Проаналізовано ринок сучасних ГІС-пакетів.

Наведена класифікація програмних продуктів (ГІС-пакет ArcGIS, MapInfo Professional, «Панорама 11» («Карта 2011»), «Digitals», GeoDraw (Geograf), AutoCad Map 3D, SAGA GIS, GRASS GIS, ILWIS, MapWindow GIS) із зазначенням функціоналу та інструментарію ГІС-пакетів. Також представлені можливості відкритих програм, що можуть бути використані в освітньому процесі (PhotoFiltre (побудова карт), XnView (перегляд), Picasa (додавання геотегів, за допомогою яких можна вказати місцевість зйомки будь-кого фото, використовуючи Google Earth і Google maps), Quantum GIS (може бути використана в якості основної платформи для навчання студентів як використовувати ГІС і як створювати найякісніші карти), мережеві сервіси Google Earth (електронний глобус), ArcGIS Online (використовується для управління і обміну картами і географічною інформацією), Golden SoftWare (Surfer) (універсальне картографічне ПО, що працює під управлінням ОС Microsoft Windows та використовується для швидкого і акуратного викреслення поверхонь карт і конвертації наданих даних у контурні, рельєфні або поштові карти, трьохвимірні поверхні, 3D-каркаси або векторну графіку)).

Розглянуто основні моделі представлення даних, завдяки яким може реалізуватися робота ГІС. Зазначено основні переваги і недоліки застосування цих моделей. Визначено основні компетенції, які повинні набути майбутні географи під час вивчення навчальної дисципліни «Геоінформаційні системи та бази даних», що дасть підстави для формування достатнього рівня конкурентоспроможного фахівця географії.

Ключові слова: ГІС-технології, ГІС-пакети, СУБД, бакалавр географії, географічні дані.

Елена Король, Олеся Корнус, Анатолий Корнус. ОСОБЕННОСТИ ИСПОЛЬЗОВАНИЯ ГЕОИНФОРМАЦИОННЫХ СИСТЕМ В ОБУЧЕНИИ БУДУЩИХ СПЕЦИАЛИСТОВ ГЕОГРАФИИ В ВЫСШИХ УЧЕБНЫХ ЗАВЕДЕНИЯХ

В статье проанализированы особенности использования геоинформационных систем в образовательном процессе в учреждениях высшего образования и обоснована необходимость их изучения в подготовке бакалавра географии (специальность 106 География). Установлена связь геоинформационных систем с другими учебными дисциплинами. Описаны темы догеоинформацийних дисциплин, которые помогут студентам беспрепятственно овладеть ГИС-технологиями. Проанализирован рынок современных ГИС-пакетов.

Приведена классификация программных продуктов (ГИС-пакет ArcGIS, MapInfo Professional, «Панорама 11» («Карта 2011»), «Digitals», GeoDraw (Geograf), AutoCad Map 3D, SAGA GIS, GRASS GIS, ILWIS, MapWindow GIS) с указанием функционала и инструментария ГИС-пакетов. Также представлены возможности открытых программ, которые могут быть использованы в образовательном процессе (PhotoFiltre (построение карт), XnView (просмотр), Picasa (добавление географических меток, с помощью которых можно указать местность съемки любого фото, используя Google Earth и Google maps), Quantum GIS (может быть использована в качестве основной платформы для обучения студентов как использовать ГИС и как создавать качественные карты), сетевые сервисы Google Earth (электронный глобус), ArcGIS Online (используется для управления и обмена картами и географической информацией), Golden SoftWare (Surfer) (универсальное картографическое ПО, работающего под управлением ОС Microsoft Windows и используется для быстрого и аккуратного черчения поверхностей карт и конвертации предоставленных данных в контурные рельефные или почтовые карты, трехмерные поверхности, 3D-каркасы или векторную графику)).

Рассмотрены основные модели представления данных, благодаря которым может реализоваться работа ГИС. Указаны основные преимущества и недостатки применения этих моделей. Определены основные компетентности, которыми должны овладеть будущие географы при изучении учебной дисциплины «Геоинформационные системы и базы данных», что даст основания для формирования достаточного уровня конкурентоспособного специалиста географии.

Ключевые слова: ГИС-технологии, ГИС-пакеты, СУБД, бакалавр географии, географические данные.

Problem statement. Today's realities require many sectors of the economy to make a clear transition to the widespread use of geographic information systems (GIS) – systems for collecting, storing, analyzing and graphically visualizing geographic data and related information. It is an automated system for working with graphical and thematic databases, which performs the functions of modeling and calculation, creation of thematic maps and atlases. It is used for scientific and practical purposes such as urban and regional planning and design, forecasting, study of natural resource potential and inventory of natural resources etc. Geographic information technologies are convenient for the analysis of various data and objects, have a high visibility of the display of heterogeneous information, provide new methods and means of information processing. GIS has been extremely widely used and today the modern world is impossible to imagine without information systems. Therefore, their use in the educational process will contribute to the informatization of education, which is characterized by the use of new methods and tools of learning, strengthening interdisciplinary links, formation of perception of a holistic, systemic picture of information processes in society, nature and cognition.

GIS have been used in cartography, meteorology, geology, economics, biology, forecasting, tourism, management and so on. The graduates of geographical specialties are involved in various institutions and departments, including geological exploration organizations, hydrometeorological services, travel agencies, spatial planning companies, in the structures of a state, regional and city administration, analytical centers, in the field of urban and spatial planning, regional and local development departments, analysts on sustainable and safe development of cities and territorial communities, urban land use, deal with environmental protection and monitoring etc. The objects of professional activity of geographers are territorial-industrial, socio-economic, natural-anthropogenic and natural systems of different hierarchical levels. Therefore, the future specialist must have the following competencies as the ability to conduct a comprehensive study of the natural resource potential of the territory and the possibilities of its economic development, regularities of formation of spatial structures of economy and forms of organization of life of society, carrying out of geoeconomic and geopolitical estimations of the countries and the world etc. It should be noted that the use of GIS in the educational process will improve the quality of training of future geography specialists. Therefore, the study of the discipline «Geographic Information Systems and Databases» in the training of geography specialists is relevant and timely and allows students to acquire relevant competencies.

Analysis of recent research and publications. Many scientific works are devoted to the use of information technologies in the educational process, in particular, the problems of informatization of the educational process in secondary and higher educational institutions are described in the work of M. Zhaldak [2], trends in the development and use of information technology in the context of the formation of the educational environment are substantiated in the study of M. Shishkina [9], trends in the implementation of Information and Communication Technologies in the educational systems of European countries are highlighted in the scientific publication of I. Malytska [5], the possibility of using Information and Communication Technologies in the educational process is characterized in the work of I. Osobova [7], Information technology of learning as a catalyst for the transformation of the educational process is presented in the work edited by E. Khvilon at al [10] and defined as a set of theoretical knowledge of comput-

er tools as well as methods governing their use in education and others. The analysis of scientific papers on the use of GIS in the educational process of training future geographers indicates a significant interest of the scientists to this technology. Thus, the expediency of introducing a cycle of disciplines of geoinformation direction is substantiated in the scientific work of a group of the authors led by V. Berezhny [1], methodological principles of teaching a block of disciplines on geoinformatics and GIS-technologies are set out in the work of S. Kostrikov [4], methodical system of teaching students of geoinformation technologies is considered in the work of O. Klochko [3]. However, the analysis of scientific publications has showed that the use of geographic information systems in the training of students of geographical specialties is insufficiently disclosed, which has determined the purpose of this study.

The purpose of the article is to clarify the peculiarities of the use of geographic information systems in the training of future geography specialists in higher education institutions (on the example of the educational process at Sumy State Pedagogical University named after A.S. Makarenko).

The main material. During the study of geographical specialties, the future specialist of geography must acquire certain competencies, among which it is worth mentioning the ability to conduct a variety of comprehensive scientific physical and socio-geographical research, create interactive electronic cartographic materials, search and analyze information, model natural and socio-economic systems, predict further processes of socio-economic development of society etc., and this is impossible without the use of GIS.

In the system of training the bachelor of geography (specialty 106 Geography) at Sumy State Pedagogical University named after A.S. Makarenko the curriculum provides for the study of a number of information disciplines and geographical, which are closely related to GIS and precede the study of the discipline «Geographic Information Systems and Databases», some are taught simultaneously and contribute to the deepening of knowledge in professional training (Fig. 1).

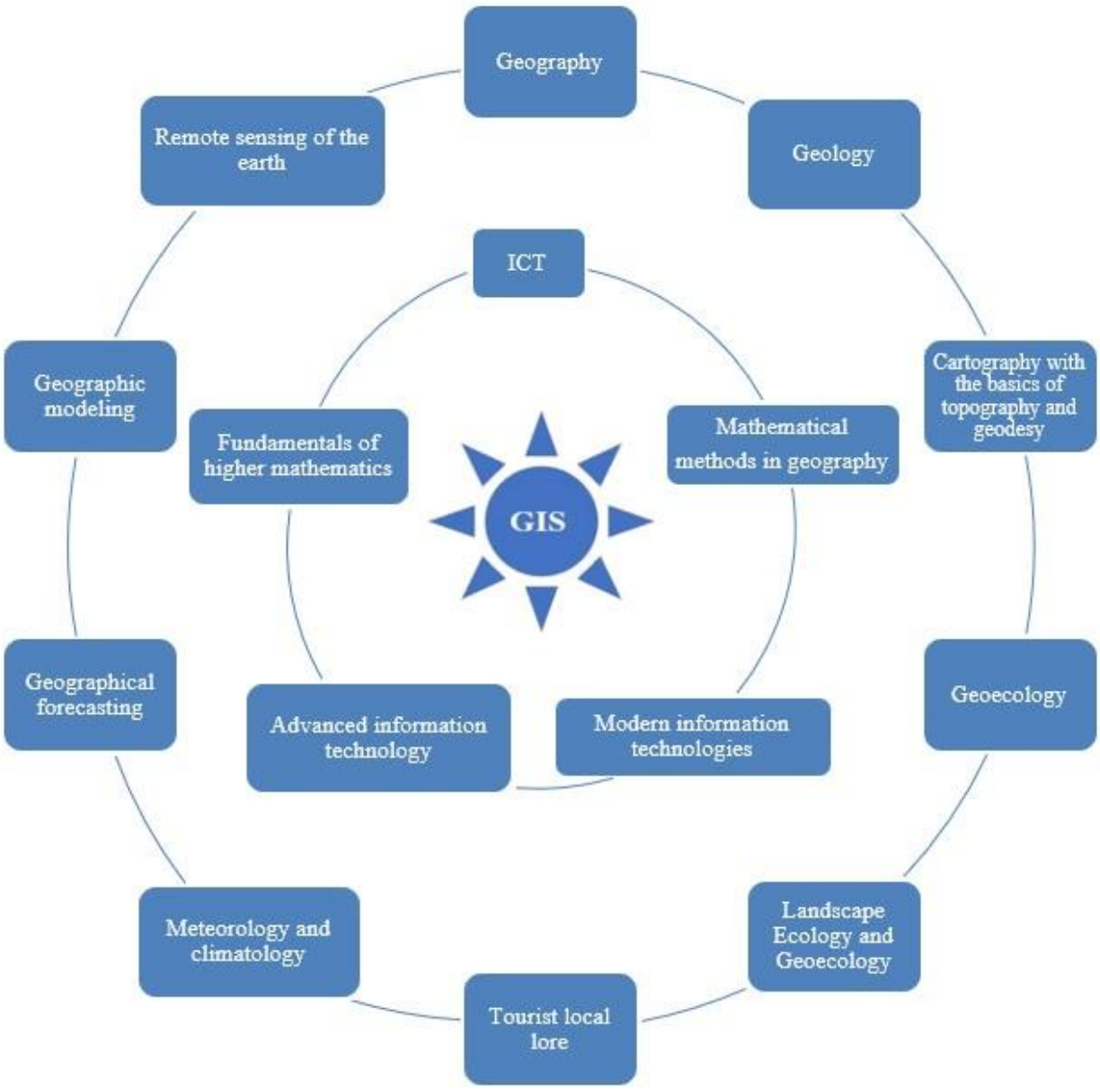

Fig. 1. Connection of GIS with other disciplines

Although there is some experience and variety in the use of different types of software, which includes GIS, their potential for educational purposes remains inexhaustible. Currently producers of different countries have developed and offer for use during the educational process the following commercial and open GIS packages, presented in Fig. 2.

These packages have significant advantages as well as disadvantages. This is mainly due to their commercial component, functionality and performance, which is both a desire and an obstacle to the implementation in higher education institutions, because the more functional and productive the GIS package, the greater its value.

It is necessary to note that alternative open GIS have certain advantages. Among the software products that can be used in the educational process and become a handy tool in the work of future geographers, which are freely available, the following software is recommended:

– graphic editors PhotoFiltre (map construction);
– XnView (preview);
– Picasa (adding geotags that you can use to specify the location of any photo using Google Earth and Google maps);
– Quantum GIS (can be used as the main platform for teaching students how to use GIS and how to create the highest quality maps);
– Google Earth network services (electronic globe);
– ArcGIS Online (used to manage and exchange maps and geographic information);
– Golden SoftWare (Surfer) (universal mapping software that runs on Microsoft Windows and is used to quickly and accurately erase map surfaces and conversion of the provided data into contour, relief or postcards, three-dimensional surfaces, 3D-frames or vector graphics) etc.

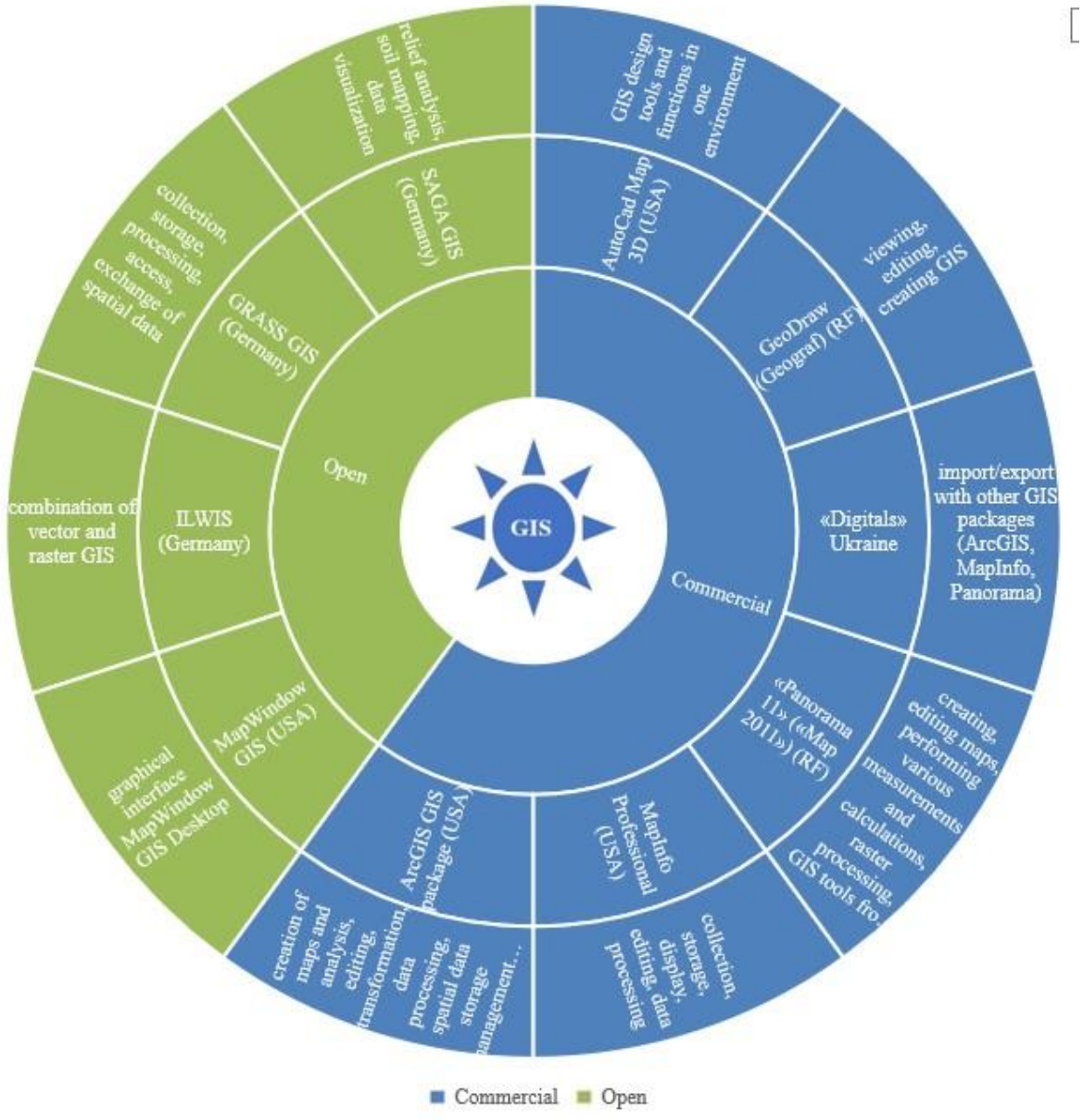

Fig. 2. Analysis of modern GIS packages

The proposed software is not limited to this list, but it can be used as the current working methods with the usage of GIS separately with maps (qualitative analysis, review, creation of maps on various topics – mapping and visualization) and can be applied in school geography.

As an example, using the PhotoFiltre graphics editor as the easiest and most affordable way to build maps, where on the contour map thanks to the toolkit of the program it is possible to put thematic information by elementary overlapping of colors, drawings and alphanumeric symbols.

It should be stressed that open GIS may not meet all modern needs, but also do not threaten the existence of other systems. Attractiveness in the usage of such software, on the one hand, is especially convenient for nonprofit organizations, institutions, where there is no extra money and thus can be used limited software functionality. On the other hand, open GIS is becoming a tool in learning new possibilities that allows users not to stand still and get acquainted with the various features and perhaps learn to improve existing software.

The analysis of separate sections of informatics and geography and the market of GIS-products allows to allocate among rather a wide range of implementation those GIS-applications, which at the same time can be based on previously obtained information knowledge and interact with geographical disciplines, presented in the curricula of the outlined specialties of the university and can be selected for use in the study of GIS technologies by future geography specialists.

Among the disciplines we have been identified those that can be compared with existing geoinformation applications, based on geographical aspects of the regional development, in territorial management, territorial design, district planning; related to natural resources, demographic research and others. These are geology, geography, cartography with the basics of topology and geodesy, geoecology, landscape ecology, tourist local lore, geographical modeling, meteorology and climatology, information systems in land management and others. Combining knowledge of these disciplines and choosing the appropriate GIS application, future professionals will be able to solve specific tasks of practical or independent work.

For example, GIS makes it possible to solve problems related to land management or spatial planning. Accordingly, the electronic map of the city can be plotted information on the infrastructure of the territory, administrative division, government, location and state of water and heat supply services, transport infrastructure, communication and communication facilities, network repair and development planning and others.

It should be noted that the training of future geography bachelors for mastering GIS should be preceded by informational training, which should cover the following topics:

1. Technical means in the work of the future geographer;
2. File system (file types, their extensions);
3. Software, their types;
4. Mastering Microsoft Office applications, with in-depth study of the database application and work with tables and charts;
5. Raster and vector graphics (examples of programs, mastering the work with tools and layers);
6. Work with professionally-oriented software (GIS, data entry programs, data visualization, map viewers etc.), namely: familiarization with the interface, tools and features of installation and configuration of these programs.

It is the professionally-oriented pre-geographic information training of future bachelors of geography that will become the basis for the successful study of GIS technologies and the key to the success of future professional training in GIS.

To improve the quality of education of future geographers in the curriculum of Sumy State Pedagogical University named after A.S. Makarenko the discipline «Geographic Information Systems and Databases» has been introduced. The aim of the course is to give students an idea of computer technology for integrated processing (input, image, PC memory, analysis and visualization) of spatially coordinated information about geographical objects.

As a result of studying the discipline students will know: the classification of modern GIS and leading companies developing GIS tools: ESRI (ArcGIS, AcrView, ArcInfo), ESTI MAP (MapInfo Professional) etc.; typical hardware and software tools for the implementation of geographic information technologies; means of data presentation in GIS; tools for developing new spatial data, diagrams, themes, layouts; tools for the development of information systems for processing geographical information using GIS development tools. Thanks to the acquired knowledge students should be able to perform basic operations of spatial analysis of digital cartographic information; work with GIS software; build the necessary database for a specific GIS project; use software such as MapInfo, ArcView, etc. to implement the project.

Upon completion of the course, students must learn the basic concepts related to: the definition of geographical information systems; mastering the main types of processing of geographical information that supports GIS (geodatabase, providing processes of geovisualization and geoprocessing); creation of a geodatabase represented by such data as maps, vector objects, rasters, topology, coordinate networks; implementation of geovisualization, during which support for map editing, content analysis and processing of user requests is provided; implementation of geoprocessing, during which the functions of spatial data processing receive information from the geodatabase, apply analytical functions to it and store the results of processing in the new elements of the geodatabase.

To master these concepts students must get acquainted in detail with the structural GIS software, consisting of basic and applied. Basic software is represented by operating systems (OS), software environments, network software and database management systems (DBMS). GIS also includes control modules for data input and output means and visualization systems. Operating systems are designed to manage PC resources and

processes that use these resources. The main operating systems are: Windows and Unix. Application software is designed to solve specialized tasks in a particular subject area and is implemented in the form of separate modules (programs) and utilities (aids).

The set of interconnected databases, classifiers, digital description rules, data presentation formats and a set of relevant documentation is the information support of GIS. It is the great ability to work with geographic data that distinguish GIS from other information systems. Geographical or geospatial data describe any objects that have localization – a spatial reference in a real terrestrial space that is having coordinates. The weather, relief, forests, fields, roads, houses and countries, cities and villages, all this and much more – objects, processes and phenomena that have coordinates, represent geographical data. Geographic data consist of two interrelated parts: spatial data describing the location, shape and size of the object, and related tabular (attributive) data (databases) describing the substantive characteristics of the object. The location, shape and size of objects in a real earth space are described and determined using coordinates. Spatial models of objects are created on the basis of the usual cartographic images thanks to which we can observe a digital map on the monitor screen.

Students also need to acquire knowledge about the application of certain data models, through which the work of GIS can be implemented. Among them are raster and vector models. Knowledge of the advantages and disadvantages of these models will help students to work with a specific GIS package, to anticipate certain obstacles in creating a GIS project at the planning stage. If we consider the raster data model, it is historically the first geodata model that was used to reflect continuous sequences of the real world. Unlike a vector model, which gives an idea of where an object is located, a raster model demonstrates that it is located at a given point on the territory.

Raster models have their advantages and disadvantages. Among the advantages, we consider that raster models can represent more accurate characteristics of the real world, have a simple mapping model, and the data are represented by a set of numbers, as if represented by a table (rows and columns). The process of formalization and data processing in the raster model is faster. Also a characteristic feature of this model is the simplicity of the processes of obtaining a raster image in vector than vice versa.

Among the significant disadvantages of raster models is the fact that during the implementation of the raster model (involved) for processing and storing data more computer memory is used. This should be taken into account both at the stage of selecting the appropriate GIS packages, and when selecting the parameters of computer equipment.

The raster model is represented by a continuous mosaic space in the form of cells that have a rectangular, triangular or hexagonal shape and are represented by homogeneous characteristics (the same color or range of colors). The smallest element of this model is a raster or pixel (pixel – abbreviated from English – picture element – image element).

A raster model is used to display continuous numerical values. Thanks to the raster, you can present images of the height of the terrain, population, the concentration of the infected population in the country or the world or the concentration of pollutants in the reservoir.

The map that represents any computer raster image of the area can be created by scanning a paper map image and processing numerical characteristics.

Unlike raster models, which are built on raster elements, the elements of a vector model are geographical objects that are vectors of coordinate pairs. This model represents discrete spatial objects digitally with a set of coordinate pairs. Therefore, the point (top), arc – a line composed of one or more segments and planes (polygons – sets of arcs) are the main concepts that are characteristic of this model of GIS. A significant advantage of this model is that vector objects take up less memory than raster ones. They are also easy to edit, scale and transform without distortion.

Vector data representation is a way of presenting digital information (point, linear and polygonal spatial geographic features) by a set of coordinate pairs describing only the geometry of the objects. This can be explained by the fact that a complex element of a geographical object can be represented by a set of simple elements (primitives: point, line, polygon), each of which has its own set of characteristics: the point is represented by one set of coordinates and has its own way of representation (for example, color); the line is represented by two sets of coordinates (beginning and end); the polygon is represented by two or more sets of coordinates. Landfill points, landfill boundaries, and landfill surface flooding can have different display modes (color, hatching type, background or mosaic etc.).

Among the models of GIS technology there is another model of data storage in the database of geoinformation data. It is based on the principle of a simple concept of relational databases and can use the full capacity of a database management system (DBMS).

From the information courses students must learn the basic rules of working with DBMS. When studying the GIS discipline, future geographers increase existing knowledge with new ones related to the purpose of simple tables used to store schemes, rules, basic and spatial attribute data for each set of geographical data. This process allows you to use a formalized model to store and work with data. This allows changes to be made, data to be supplemented and queries to tables and their elements to be executed.

Based on the experience of the leading experts in the field of teaching GIS technologies, we agree that students must learn to obtain geographic information using GPS, graphical user interfaces and the functionality of leading GIS platforms and geoinformation modeling modules [1].

To develop practical skills in the visualization of already acquired knowledge about geographical processes, phenomena and their dissemination, work is proposed to decipher images from space. A certain percentage of practical activities is related to the analysis of those sample images, which contain deciphering data of specific objects, and the rest of the activity should be devoted to the analysis of images of the territory already known to students (for example, settlements from the

place of study and place of birth).

In the process of acquiring knowledge students are offered to work with the Google Earth service as a search for geospatial features of the specified area. They are also offered work on creating simple photos, which takes place in the same software product, by editing images from space, namely adding contours of objects to the territory, changing them, superimposing new images etc. It also demonstrates the interactive properties of working with the Google Earth service, which can be used as a variant of GIS.

Conclusions. The implementation of geographic information technologies in the educational process opens new opportunities for better training of geography specialists. However, more attention should be paid to both pre-geographic information training of students and the formation of the content of geographical disciplines and methods of presenting the material. Future geographers should be introduced to the functionality and performance of existing GIS software packages on the world market (GIS package ArcGIS, MapInfo Professional, «Panorama 11» («Map 2011»), «Digitals», GeoDraw (Geograf), AutoCad Map 3D, SAGA GIS, GRASS GIS, ILWIS, MapWindow GIS) and open source software (PhotoFiltre, XnView, Picasa, Quantum GIS, Google Earth Network Services, ArcGIS Online, Golden Soft-Ware (Surfer)) that can be recommended for use in the educational process. It is necessary to teach students to present information data in digital form, to process this information thanks to GIS technologies, which will allow to apply the acquired knowledge in professional activities. This will give foundations for the formation of a sufficient level of competitiveness of future professionals. The use of GIS in the training of geographers contributes to the formation of professional competencies and provides a qualitatively new level of acquisition and generalization of knowledge, skills and abilities.

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