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CHALLENGES DIGITALIZATION CONSTRUCTION INDUSTRY: TRAINING FUTURE MASTERS URBAN PLANNER IN RUSSIA

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The article is devoted to the development of a new educational program "Geoinformatics and Data Processing in Urban Planning" for future masters studying in the Master's program "Urban Construction and Development of Infrastructures" at the Institute of Construction and Architecture of the Ural Federal University. The new program is based on the use of methods of statistical analysis of spatial data for solving applied urban planning problems. The program is focused on use in the digitalization of the construction industry. The structure of the content of the educational-methodical complex of the discipline includes: methodological recommendations for its use in the educational process for the teacher and for the student; theoretical material of the training course, a list of basic and additional literature for studying the discipline; a set of laboratory works with guidelines for their implementation; control and measuring materials to check the levels of mastering of educational material during traditional types of control: exams, control works, tests, term papers.

Keywords: undergraduates; digital economy; digitalization of construction; Geoinformatics; urban planning; educational and methodological complex.

Introduction

Research problem. An analysis of the current economic situation in Russia made it possible to state that some of the sectors of the economy traditionally considered to be the "least digital", such as mining, agriculture, construction and utilities, are currently among the sectors with the highest growth rates of technological investments, i.e. e. the nature of the digital economy is changing. This fact entails changes in the field of education, presenting new requirements for the quality of modern education to graduates of higher educational institutions [1].

According to the strategy for the development of the information society in Russia for 2017-2030, approved by the Decree of the President of the Russian Federation of 09.05.2017 No. 203 [2], the digital economy is understood as "economic activity in which the key production factor is digital data, and the use of the analysis results of which, in comparison with traditional

forms of management, can significantly increase the efficiency of various types of production, technologies, equipment, storage, sale, delivery of goods and services "[2]. This means that in the digital economy, a master of the Institute of Construction and Architecture (IC&A) of the Ural Federal University (UrFU) must not only confidently own information and communication technologies (ICT) tools as a tool for collecting, accumulating, processing, storing, transferring, using, producing information in his professional field, but also know and be able to use digital technologies in their professional activities.

One of the priority directions of scientific, educational and innovative activities of Ural Federal University is "Construction", within which it is necessary to create and introduce into the educational process new, modern educational programs for training students in the field of construction, which determines the research problem.

Relevance. Today, in the Ural Federal District, no university provides undergraduates with the skills of statistical analysis of spatial data for solving such applied problems of urban planning as functional zoning of territories, redevelopment of built-up areas or the mutual influence of spatial and social parameters of the urban environment. This gives the right to believe that on the basis of the new discipline, a course of additional professional education (APE) can be built in the future, which will be in demand among colleagues from other universities. At the same time, none of the universities of the Ural Federal District (UrFD) is implementing a single master's program addressed to builders and urban planners, of which geoinformatics would be a part.

This fact makes the developed educational product unique within the specialty and region and determines *the relevance of the research.*

The purpose of the study is to develop a new educational discipline "Geoinformatics and Data Processing in Urban Planning" for the master's program "Urban Construction and Development of Infrastructures", which has been operating since 2017, focused on use in the digitalization of the construction industry.

To achieve the research goal, it is necessary to solve the following *tasks:*

− to determine the minimum requirements for hardware and software for the implementation of the electronic version of the educational and methodological complex of the discipline (EMCD) "Geoinformatics and data processing in urban planning";

− to develop methodological recommendations on the use of the EMCD in the educational process for the teacher and for the student;

− to develop the theoretical material of the training course for the discipline, as well as a list of basic and additional literature for the study of this discipline;

‒ to develop a description of laboratory work in this discipline with guidelines for their implementation;

‒ to develop control and measuring materials to check the levels of mastering of educational material (control at the level of ideas, final control, control of knowledge and formed skills, control at the level of creativity) during all traditional types of control: examinations, tests, tests, term papers.

The scientific novelty of the research consists in identifying the possibilities of methods of statistical analysis of spatial data for solving such applied problems of urban planning as functional zoning of territories, redevelopment of built-up areas or the mutual influence of spatial and social parameters of the urban environment, and justifying their implementation to improve the training of masters in urban planning.

The theoretical significance of the research lies in the theoretical substantiation of the content of the new discipline "Geoinformatics and Data Processing in Urban Planning", the organizational and methodological goals of its implementation in the preparation of masters in the program "Urban Construction and Development of Infrastructures", information interaction of subjects of the educational process in its use, as well as theoretical substantiation of the content of the levels of competence formation of masters in the field of applying the skills of statistical analysis of spatial data for solving applied problems of urban planning.

At the moment, the Institute of Construction and Architecture of UrFU is at the beginning of the path to form a block of educational programs for the digital economy.

In this sense, the proposed course is built into a stable trend towards the automation of all processes of human activity, which will allow remote control of objects of the objective world connected to the Internet, as well as the operation of sensors that monitor the functioning of objects in real time [2] in the construction industry.

The purpose of the publication follows from the purpose of the research and is to describe the process of developing a new academic discipline "Geoinformatics and Data Processing in Urban Planning", the content of the educational and methodological complex of the discipline, as well as educational and methodological materials for its use within the Master's program "Urban Construction and Development of Infrastructures", implemented at the Institute of Construction and Architecture of the UrFU.

Literature review

The developed educational product belongs to the sphere of practical activity of urban planners, which has been rapidly changing over the past 5 to

10 years. During this time, many foreign universities have integrated modules on database administration, data analysis, geoinformatics and even programming into undergraduate and graduate programs [3, 4].

A similar situation is observed in the domestic higher education. The pioneers in the development of specialized education here are the Higher School of Economics and the St. Petersburg State University of Information Technologies, Mechanics and Optics (ITMO), where such master's programs as: "Management of spatial development of cities" [5], "Urban planning and urban design" [6].

The content of the new educational product is largely based on the experience of these universities. In the near future, a specialist in the field of urban construction will need to have experience in using Excel and OpenCalc to clean and transform tabular data, generate macros, apply linear and spatial regression models to explain space-time irregularities, experience in database administration, etc. A significant part of the methodological support of the developed course is made up of educational and methodological materials published by the authors of this article [7, 8] and prepared for publication in 2020. In the course of work on the content of the new discipline, a number of undergraduate and graduate educational programs implemented in Russia were studied, aimed at developing competencies in the field of data processing:

- "Territorial planning and design based on the study of the spatial structure of the city" [9];
- "Programming for Urban Data Analysis" (HSE) [10];
- "Methods of Spatial Analysis" (HSE) [11].

Such programs are used in the educational process of the Massachusetts Institute of Technology [12].

In particular, from the experience of teaching similar disciplines at the Massachusetts Institute of Technology, it is planned to adopt the practice of short assignments at the end of each lesson. Students should write the ideas that come to mind in connection with the material they have learned in five minutes. The answers allow the teacher to assess the level of competencies formation and accumulate material for seminars.

Methodology and methods

The methodological basis of the research was the fundamental works in the field of: theory and methods of vocational education (S.I. Arkhangelsky [13], V.A. Slastenin [14], N.F. Talyzina [15], etc.); theory and practice of informatization of education (Vagramenko Ya. A. [16], Kozlov O.A. [17], Pak N.I. [18], Robert I.V. [19] and others); the theory of the competence-based approach (Zeer E. F. [20], Zimnyaya I. A. [21], Pak N. I. [18] and others).

The creation of a new educational program for the discipline "Geoinformatics and Data Processing in Urban Planning" is based on two principles. On the one hand, geoinformatics is viewed as a discipline that can become a general incentive for professional growth for bachelors of various specialties entering the master's program in Urban Construction and Infrastructure Development. The methods of statistical processing of spatial data basically remain the same for a wide range of construction, transport, and management industries. The result of mastering accurate methods for analyzing the urban environment in the context of issues of transport, economic or social development will be the ability of students to adapt them to specific construction tasks.

On the other hand, the new course is designed to form competencies, the demand for which in the labor market is just forming, but in the course of further digitalization of urban planning, it will grow in the near future. Recent trends suggest that construction and urban planning, traditionally considered the "least digital" sectors of the economy, are now among the sectors with the highest growth rates for technology investment. The process of urban development today has accelerated so much that traditional methods of regulating it with the help of "paper" documentation do not allow timely response to changes. As part of the discipline being developed, undergraduates will get acquainted with the fundamentals of the methods used today in the framework of geomarketing for the operational adaptation of business to the changing parameters of the urban environment.

At the same time, the development of a new discipline was immediately focused on implementation in an electronic presentation format (electronic educational and methodological complex, EEMC). According to [22], the main pedagogical tasks solved when using the teaching materials in the educational process of the university include: the student's independent acquisition of knowledge using various sources of information; the ability to work with the collected information using various methods of cognitive activity; practical application of the acquired knowledge to solve applied problems of urban planning; the ability to use an electronic educational resource at a time convenient for the student; using the latest teaching technologies such as collaborative learning, project method, case analysis, teamwork, problem learning, etc.; active interaction of students with the teacher and among themselves in working groups; systematic monitoring of learning outcomes based on operational feedback, ongoing automatic monitoring and delayed monitoring.

The implementation of the listed pedagogical provisions in the process of mastering the discipline within the framework of the master's program is aimed at improving the quality of training of masters for the construction

industry in the context of its digitalization, and in general will increase its importance both for the Institute of Construction and Architecture and for the Federal University.

Results and discussion

In accordance with the general concept of digitalization of the domestic economy, in the course of the study, the concept of digitalization of construction was clarified: *by digitalization of a construction object or process we mean the transformation of data about a construction object or a process from analog to digital form using digital technologies, followed by automated analysis of digital data and adoption of the optimal in a sense, a management decision to improve production or business in the field of construction.*

In other words, we can say that digitalization of construction involves the introduction of digital technologies in various areas of construction activities. Digital technologies include: Big Data - big data, machine learning, neural networks, artificial intelligence, human-machine interfaces, virtual reality, the Internet of things, robotization.

Examples of digitalization are smart homes, robots in factories, self-driving cars, etc. The goal of digitalization is to automate the transition of information about an object or process from an analog form to a digital form that is easier to analyze, and based on the analysis, an accurate solution is obtained that is aimed at improving production or business.

The development of a new educational program is based on the implementation of practice-oriented, information technology and competency-based approaches. The mastery of the discipline is provided within the framework of e-learning in combination with traditional lecture and practical classes, independent and project work in groups.

Since within the discipline it is planned to use both traditional approaches to information processing, formed back in Soviet times, as well as modern foreign and domestic examples of the practical use of big data to address issues of urban planning and the development of urban systems, an increase in general interest in scientific work and modern digital technology among students. This will allow already in the second year of the master's degree to attract students to research work on grants and practical design. The presence of trained and motivated young personnel will stimulate the professional growth of the teaching staff of the university, contribute to the development of scientific schools in relevant areas.

In terms of organizational changes in the current curriculum, it will be necessary to transfer the discipline "Geographic Information Systems" to the

first semester of the first year of the Master's program, and for the discipline "Mathematical Modeling" - to formulate a request for updating the content.

In accordance with the current Educational Standard of UrFU for the development and implementation of master's programs in the field of Engineering, Technology and Technical Sciences, the developed discipline is focused on the formation of universal and general professional competencies, with which the master:

– is able to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy;

– is able to formulate and solve research, technical, organizational, economic and complex tasks, applying fundamental knowledge;

– is able to plan and conduct comprehensive research and research to solve engineering problems related to professional activities, including measurements, planning and setting up experiments, interpretation of the results obtained

The following is a description of the content structure of the educational-methodological complex of the discipline "Geoinformatics and data processing in urban planning" (EMCD).

The block "About the educational methodological complex" contains information about the authors of the developed EMCD, as well as the minimum requirements for hardware and software.

"Methodological block" contains methodological recommendations on the use of the EMCD for the teacher and for the student.

"Information block" includes the theoretical material of the course in the form of electronic lectures, as well as a list of basic and additional literature for studying this discipline.

"Educational block" includes a description of all laboratory work in this discipline with guidelines for their implementation.

"Control block" allows you to implement all the traditional types of control: exams, tests, tests, term papers. Moreover, the control tasks are selected in such a way as to check all the levels of mastering the material (control at the level of ideas, final control, control of knowledge and formed skills, control at the level of creativity).

For control at the level of representations, it is advisable to place questions for self-examination, which the student must answer after studying each lecture.

Measuring materials for the final control of students' knowledge will allow control at the level of reproduction.

Questions for the exam (or test), placed in the control block, will give an idea of the availability of knowledge and the level of formed skills.

Control at the level of creativity is carried out in the process of completing essays, term papers, as well as independent work. Therefore, the control block contains the topics of essays and term papers, as well as tasks for independent work. When developing an electronic version of the EMCD, it is necessary that the issues of measuring materials should be distributed among the elements of the EMCD, and inside the element by sections, topics, laboratory work, etc. The electronic EMCD should allow working in two modes: self-control and control by the teacher. In case of self-control, depending on the mode chosen by the student, if the test results are unsatisfactory, the program may deny him access to subsequent sections. The teacher control mode assumes the presence of a list of control tasks, formed from a general list of control questions in a random way. In this case, the test results are transferred to the general database of students. They are viewable by the teacher.

The "Glossary" block contains an explanatory dictionary of all scientific terms of the developed discipline that a student needs to know after studying the discipline.

As can be seen from the description of the content structure of the EMCD, it fully covers the traditional forms of education and contains absolutely all the information necessary for mastering the course being studied.

Thanks to the introduction of the discipline "Geoinformatics and Data Processing in Urban Planning" into the Master's program "Urban Construction and Development of Infrastructures", which has been in force since 2017, it is planned to increase the number of quantitative methods used by students in solving research and design problems; improving the quality of master's research papers; introduction into practice and participation of graduate qualification works, protected under the program, in Russian and international competitions.

Conclusion

Within the framework of the study, it was found that the current state of the training of masters studying under the program "Urban Construction and Development of Infrastructures" is not focused on the formation and improvement of knowledge and skills in the field of statistical analysis of spatial data for solving applied problems of urban planning (functional zoning of territories, redevelopment built-up areas, the mutual influence of spatial and social parameters of the urban environment).

As a result of the study, a new educational discipline "Geoinformatics and Data Processing in Urban Planning" was developed, which implies implementation within the framework of the current master's program "Urban

Construction and Development of Infrastructures", focused on use in the context of digitalization of the construction industry.

The structure of the content of the educational-methodical complex of the developed discipline includes: methodological recommendations on the use of the EMCD in the educational process for the teacher and for the student; theoretical material of the course in the discipline, a list of basic and additional literature for the study of this discipline; a set of laboratory works with guidelines for their implementation; control and measuring materials to check the levels of mastering of educational material during traditional types of control: exams, control works, tests, term papers.

As a result of the implementation of the developed discipline, IC&A masters will be able to: use the program interfaces of applications of geoinformation services, write programs for collecting data on the Internet, cleanse and transform spatial data for statistical analysis, apply linear and spatial regression models to explain space-time irregularities, use tools MS Excel for statistical analysis and database administration. As a result of the implementation of the new discipline, an increase in the competition for budget places when studying for a master's program is expected and, in view of its demand, a possible increase in the cost of paid education.

The result of the implementation of the developed discipline will be assessed by the level of formation of professional competencies in the use of geoinformatics tools and data processing in urban planning. For this, it is planned to develop a model for assessing the level of formation of competencies based on the method of standardization of ranks, which has not yet been used for these purposes [8]. This model allows one to obtain numerical intervals for determining the level of formation of professional competencies of masters in the field of urban planning.

The practical significance of the developed training course lies in its focus on use within the digitalization of the construction industry and accelerating the appearance on the labor market of specialists in the field of urban planning who are able to communicate in the same language with colleagues involved in database management, remote sensing, social network analysis, creation of sensory and robotic equipment.

It will be easier for new urban planners, trained according to the developed program, to integrate into the management processes of Smart Cities, where representatives of other professions are now running the show.

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