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UPDATING EDUCATION CONTENT OF FUTURE BACHELORS IN COMPUTER SCIENCE: END-TO-END DIGITAL TECHNOLOGIES

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Abstract

It is impossible to imagine modern education without digital technologies. They are fundamental and most relevant for the effective development of this area. Within the framework of the federal project "Digital Technologies" of the national program "Digital Economy", there is a list of end-to-end technologies that are prior for the development of digital economy. For their development and research in this area, fundamental knowledge of mathematics, computer science and technology is required. These requirements are presented by virtual and augmented reality, 3D printing, big data processing, block chain technology, quantum technologies and fifth generation (5G) communications. The program proposed by the author is intended for future first-year computer science bachelors who show a high interest in technical creativity, advanced areas of discrete mathematics, computer science, digital technologies, as well as active participation in regional events in the field of mathematics education, robotics, scientific and technical creativity (competitions in mathematics, robotics, master classes, lectures and special sessions). The purpose of mastering the developed content of education is to deeply master the mathematical foundations of computer science by future bachelors for their use in the study of end-to-end digital technologies: virtual and augmented reality technologies, robotics and sensorics, wireless communication technologies, new production technologies, quantum technologies, neurotechnologies and artificial intelligence, orientation in creation of conditions for communication and motivation, training and professional orientation of students in research activities for possible continuation of their studies in master and postgraduate program and subsequent work at enterprises in specialties related to robotics and digital technologies.

Keywords: Digital technologies, digital economy, end-to-end technologies, educational content of future computer science bachelors

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1. Introduction

In recent years, another direction of transformation of business and social models of activity has started, caused by the emergence of new generation of digital technologies, which, due to the scale and depth of influence, received the name "end-to-end" – artificial intelligence, robotics, the Internet of things, wireless technologies etc.

"End-to-end" digital technologies are technologies used to collect, store, process, search, transfer and present data in electronic form, the operation of which is based on software and hardware tools and systems that are in demand in all sectors of economy, creating new markets and changing business processes.

According to the assessment their implementation can increase productivity in companies by 40%. In the near future, it is the effective use of new digital technologies that will determine the international competitiveness of both individual companies and entire countries that form the infrastructure and legal environment for digitalization (Vezirov et al., 2013).

2. Problem Statement

Russia depends on global trends in the development of digital technologies. We have to face all the consequences of digitalization, which are already generating fundamental changes in the models of economic activity and social life in leading countries. It is necessary to note that the faster the pace of implementation of digital technologies, the more difficult the tasks of managing the formation of digital economy and digitalization of education are. Therefore, graduates of our universities should be competitive and popular at labor market (Vezirov et al., 2014).

3. Research Questions

The educational program "Mathematical Informatics" composes of three modules. They include "Discrete Mathematics", "Mathematical and Computer Modeling", "Solution of Olympiad tasks, Training of Future Teachers of Informatics to Solve Problems of the most difficult tasks of Basic State Examination (BSE) and Unified State Examination (USE)".

The content of the module "Discrete Mathematics" includes: basic concepts of mathematical informatics, matrices, arrays, information representation in a computer, the elements of the theory of algorithms, signal processing, logic, combinatorics

In this regard the indicators of success are presented by the ability to correlate the actions with the planned results, monitor the activities in the process of achieving a result, determine the methods of action within the proposed conditions and requirements, adjust the actions in accordance with the changing situation; the ability to define concepts, create generalizations, establish analogies, classify, independently choose the grounds and criteria for classification and skills to establish cause-and-effect relationships, build logical reasoning, inference (inductive, deductive, and by analogy) and draw conclusions. This list also includes the ability to put forward hypotheses during the solution of a problem, understand the need to test them; understanding the essence of algorithmic prescriptions and the ability to act in accordance with the proposed algorithm (Sorokopud et al., 2018).

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The content of the module “Mathematical and computer modeling” includes the study of the concept of a model, assessment of the adequacy of a model, computational experiment on a model and computer modeling.

Here the indicators of success are presented by the possession of methods of mathematical modeling and design in the context of new production and quantum technologies, the development of neurotechnology and artificial intelligence; the ability to understand and use mathematical means of visualization (graphs, tables, diagrams, etc.) for illustration, interpretation, argumentation; the ability to find information from various sources that is necessary to solve mathematical problems and present it in an understandable form, make a decision under the conditions of incomplete or redundant, accurate or probabilistic information.

The content of the module “Solution of Olympiad Tasks. Training for Basic State Examination (BSE) and Unified State Examination (USE)” includes the main sections of algebra, geometry, mathematical analysis.

The indicators of successful mastering are the understanding of basic mathematical concepts and laws, ability to think logically and ability to communicate.

The educational program “Project activity” includes such modules as “Technologies of project work”, “Activities of the future”, “Experiment in a research project”.

The content of the module “Technologies of project work” includes project concepts, typology of projects, project results, determination of positions in a project team, problem statement, life cycle of projects.

The indicators of success are the possession of communication skills, leadership, cooperation, diplomacy; the ability to build relationships in a team, ability to present ideas, ability creatively solve open problems, including social issues.

The content of the module “Activities of the future” includes practicing projects for the future, education of the future, technologies of the future and professions of the future.

The indicators of success are the ability to achieve success during the implementation of an idea in any existing practice, as well as to implement a brand new idea; the possession of public skills; the ability to present own ideas and creatively solve open problems, including social issues; the ability to build a trajectory of personal development; possession of self-development skills; the possession of social adaptation skills, contributing to the solution of professional tasks, tasks of social participation and personal growth, regardless of the specific direction of professional activity; the ability to adapt and work effectively in different cultures (Abdullaev, 2015).

The content of the module “Experiment in a research project” includes the concept of scientific research, engineering projects and the choice of a research topic, hypothesis formulation and formulation of a topic, problems, experiment planning and verification of obtained data.

The indicators of success are the possession of communication, leadership, cooperation and diplomacy skills; the ability to build relationships in a team; the ability to present own ideas and creatively solve open problems, including a research plan.

The goals and values of the organization of mathematics and informatics education of future bachelors of informatics are aimed at deep study of the mathematical foundations of informatics, which

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allow fundamentalizing the education of students. This is reflected in the principles mentioned below (Abdullaev et al., 2019).

The principle of democratization presupposes the independence of the structural unit and teachers in the choice of the purpose, content, development program and educational program of a particular institution, the specifics of the organization of activities.

The principle of freedom of choice is realized in the unity with the principle of conformity to nature and culture. A synergetic association, a trinity of conformity to nature, conformity to culture and conformity to freedom is meant. This provides that a student is treated as a complex subject, capable of active manifestation in activity and the search for his own identity. This principle also includes the wide use of play techniques and creation of emotionally significant situations.

The principle of subjectivity is in the fact that a participant independently determines the goals, the degree of the occupation with the activities he needs in accordance with his capabilities and abilities. Only realizing his motives, needs, opportunities, abilities, goals and knowing how to implement them, a person is able for self-fulfillment.

The principle of self-actualization and self-fulfillment presupposes the orientation towards the development of motivation for cognition and creativity, the need of a student to actualize his intellectual, creative, communicative abilities and capabilities.

The principle of cooperation has several levels: cooperation between administration and teachers and cooperation between teachers and students.

The principle of productivity is the obligation to obtain a product of independent activity, which is one of the important conditions for self-education. The product of a particular activity within the framework of a project may be the development of projects by students in the field of end-to-end digital technologies such as arduino, artificial intelligence, aeronet and energynet.

4. Purpose of the Study

The purpose of mastering the program is in-depth study of the mathematical foundations of computer science and end-to-end digital technologies: virtual and augmented reality technologies, robotics and sensorics, wireless communication technologies, new production technologies, quantum technologies, neurotechnologies and artificial intelligence. The creation of conditions for communication and motivation, training and vocational guidance of students for the possible continuation of their studies in higher education institutions and subsequent work at enterprises in specialties related to robotics and digital technologies (Sadulaeva, 2016).

5. Research Methods

In order to implement the developed updated content of mathematical education for future bachelors of computer science, the following methods are proposed:

1. Case technology or Case Method – method of specific situations, method of situational analysis. It is a learning technology that uses real economic, social and business situations as a learning task. Students should study the situation, understand the essence of the problem, suggest possible

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solutions and choose the best one. The cases are based on real factual material or are close to a real situation.

2. Gamification – the use of gaming approaches, which are widespread in computer games, for non-gaming processes, which allows increasing the involvement of participants in the solution of applied problems, using products, services and increasing customer loyalty.

3. Design Thinking is a technology for the solution of engineering, business and other tasks based on a creative rather than analytical approach, putting forward the request of a user. In contrast to analytical thinking the main feature of the use of the technology of design thinking in education is not critical analysis, but a creative process in which sometimes the most unexpected ideas lead to the best solution to the problem.

4. Foresight technologies (a look into the future) are the formation of ideas about the future by processing the opinions of the target audience. It is the main element of many design technologies.

5. Edutainment (education and entertainment) is any entertainment activities that include an educational component. This technology is a symbiosis of pedagogy, psychology and computer science and is a special type of education, which is based on entertainment and the formation of primary interest in subject with enjoyment of the learning process and a strong interest in learning process.

6. Technology of developing education is the principle of teaching at a high level of difficulty, at a fast pace, here the leading role is given to theoretical knowledge. The technology is characterized by the stimulation of the reflection of students in various situations of educational activity.

7. The technology of adaptive learning is a kind of technology of multilevel education. It assumes a flexible system of the organization of training sessions, taking into account the individual characteristics of students. The central place in this technology is given to a student, his activities and the qualities of his personality. Particular attention is paid to the formation of their educational skills. During the use of adaptive learning technology, priority is given to independent work. This technology makes it possible to purposefully vary the duration and sequence of training stages.

8. Technology of project training is a technology based on Dewey's ideas about the organization of educational activities in order to solve practical problems taken from everyday activities. Each student gets the opportunity for real activity, in which he shows his individuality and also enriches it.

6. Findings

As a result of the research, a curriculum for the discipline “Mathematical Foundations of Informatics” was obtained formed. It includes:

Module 1. Basic concepts of mathematical informatics. Introduction of basic concepts about the subjects of mathematical logic, computational and discrete mathematics, constructive mathematics, mathematical statistics, information theory, theory of languages and grammars, fuzzy set theory.

Module 2. Matrices. Arrays. One-dimensional vectors and two-dimensional matrices, operations on one-dimensional vectors, operations with matrices, matrix transposition, inverse matrices, matrix loops. Arrays. Array creation. Array creation and modification. Determination of the length of an array. Conversion between array rows.

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Module 3. Presentation of information in a computer. Representation of integral numbers. Direct code. Additional code. Integer arithmetic in a limited number of digits. Normalized notation of real numbers. Floating point representation. Presentation of text, graphic, sound information. Compression methods for digital information.

Module 4. Sets, binary logic, combinatorics. Sets and operations with sets: union, intersection, exclusion. Binary logic: variables of the form 0/1, operations with binary variables. The basics of combinatorics.

Module 5. Mathematical and computer modeling. Model concept. Assessment of the adequacy of a model. Computational experiment according to a model. Computer modelling.

Module 6. Theory of algorithms. Algorithm concept. Properties of algorithms. Types of algorithms, methods of writing algorithms. Solution of problems for the compilation of algorithms. Clarification of the concept of the algorithm. Turing machine. Post machine as a refinement of the concept of an algorithm. Algorithmically unsolvable problems and computable functions. Search algorithms. Sorting algorithms.

Module 7. Signal processing. Sampling and quantization, spectrum, Fourier transform, frequency filters. Basics of digital signal processing.

Module 8. Solution of Olympiad tasks. Solution of the most difficult tasks and tasks of the second part of BSE and USE.

Module 9. Development of meta-competencies. Self-identification. Artificial Intelligence. Communication: globalization and intercultural communication. Social partnership and community creation. Conscious leadership. Broadcast of values and historical heritage. Science and Research: Critical Thinking. Creative research. Science as a trend. Innovation. Economy: digital environment. Education in the context of sustainable development.

Final examination. Olympiad. Presentation of projects.

7. Conclusion

Mathematics and computer science occupy a special place in science, culture and social life as one of the most important components of world scientific and technological progress. The study of mathematics and computer science plays a paramount role in education, developing human cognitive abilities, including logical thinking, influencing the teaching of other disciplines.

Nowadays it is impossible to imagine digital economy without machine learning, big data processing and artificial intelligence. These sections are based on the connection of deep knowledge of mathematics and computer science. It is impossible to fulfill the task of the creation of an innovative economy without a high level of mathematical education (Konopko et al., 2019).

Mathematical education is a necessary component of general education, providing students with the opportunity to apply knowledge of the basics of science in practice, to master general principles and specific skills of the transformation of human activity, various forms of information and material culture.

Mathematical informatics is the organization core of entering the world of modern end-to-end digital technologies (Sadulaeva et al., 2019).

One of the important tasks of socio-economic development and human resources development for digital economy in the Chechen Republic is the popularization of mathematical and information education among the youth.

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References

Abdullaev, D. A. (2015). *Formation of the readiness of future bachelors to use Internet technologies in the educational process* [Doctoral Dissertation]. Makhachkala.

Abdullaev, J. A., Pankratova, O. P., Konopko, E. A., & Nersesyan, E. (2019). Training of Teachers for Professional Activity in the Digital Enviroment of the Educational Space. In *Proc. of SLET-2019 – Int. Sci. Conf. Innovative Approaches to the Application of Digital Technologies in Education and Research* (pp. 205–212). Dombay. http://ceur-ws.org/Vol-2494/paper_18.pdf

Konopko, E. A., Bogatyreva, Y., Privalov, A., & Romanov, V. (2019). The Organization of Scientific Research Work of Students in the Conditions of the Digital Environment in the Modern Universities. In *Proc. of SLET-2019 – Int. Sci. Conf. Innovative Approaches to the Application of Digital Technologies in Education and Research* (pp. 95–103). Dombay. http://ceur-ws.org/Vol-2494/paper_7.pdf

Sadulaeva, B. S. (2016). *Competence-oriented teaching of mathematical informatics for future bachelors of the "Informatics" profile (on the example of the course "Elements of Mathematical Informatics")*. *Monograph*. MIGUiP.

Sadulaeva, B. S., Abdullaev, D. A., & Muradova, P. R. (2019). Development of ICT competence of school organizers. *European Proc. of Social & Behavioral Sciences*, *76*, 2713–2719.

Sorokopud, Y. V., Nikolaev, M. V., Zinchenko, A. S. (2018). Implementation of pedagogical coaching in the educational space of the university. *J. of Fundam. and Appl. Sci., 10*(5S), 980–992.

Vezirov, T. G., Borozinets, N. M., Sorokopud, Y. V. (2013). The experience of the usage of information technologies in preparation of future teachers in the global educational practice. *Middle East J. of Sci. Res., 18*(1), 4–8.

Vezirov, T. G., Guseynov, R. J., & Sultanov, E. S. (2014). Russian experience of the unesco's programs realization in the sphere of informatization of the pedagogical education. *Biosci. Biotechnol. Res. Asia, 11*(3), 1631–1638.