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Improving information technology training of the future specialists in the higher educational establishments in the conditions of digital economy

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Abstract. The paper is devoted to one of the most important directions of development of the system of higher education in the era of digitalization, i.e. the information technology training of future specialists. In this work, the need to improve the information technology training of bachelors and masters in the university is substantiated as one of the components of fundamental training of a modern specialist for the digital economy of Russia. On the basis of analysis of relevant theoretical, methodical, and technological approaches of domestic and foreign scientists and practitioners to the issues of improving information and technological training of students in the university, the authors of the article: (i) consider the distinctive features of modern information technology training of students requiring close cooperation of higher education institutions with the labor market in order to promptly adjust the content of curricula in accordance with employers' requests, as well as to follow the concept of advanced education; (i) emphasize that, despite the digital transformation of educational process, changing forms, and methods of teaching, and competences, the most important requirement for the updated system of information technology training of students is to maintain its fundamental nature; (ii) emphasize the importance for future specialists to have programming skills, and their readiness to interact with information systems and technologies, as well as the ability to engage an independent and productive dialogue with computers, make decisions and perform assigned professional tasks and manage complicated automated complexes; (iii) justify and systematize the principles of selection of the content of information technology training for the higher educational establishments' students, taking into account the requirements of Federal State Educational Standards for the Higher Education (FSES HE), domestic and foreign standards in the field of information technology, as well as the concept of advanced education; (iv) offer a system of methodical and technological approaches to improving the information technology training of future specialists in the higher educational establishments using practice-oriented and optimization approaches, advanced education, and e-learning using distance education technologies.

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1. Introduction

At present, Russia, like all progressive mankind, has entered a new phase of information development, which is usually called the era of digitalization.

At the current stage, digitalization of the economic system is the main direction of development of the state, economy and public relations in Russia.

Digital economy is the economy of a new technological generation using a huge amount of data produced in a wide variety of information systems [1].

Already today, quite a large part of the employed population of Russia is moving from the sphere of production of traditional types of goods and services to the information sphere, where it participates in the processes of accumulating, storing, searching, processing and redistributing information, creating information products and services.

It should be emphasized that digital economy, based on digital technologies, involves a new way of technological production, requiring new specialists and new conditions for development. Therefore, the sphere of education is one of the key and most promising areas of global competition among the states for economic power and political influence in the 21st century [2].

The level of education in the situation of digital economy formation in the country must outstrip the level of development of society and the production system. In relation to a personality, the process of advanced education is based on the implementation of the principle of self-development of an individual, which assumes that the individual should have not only knowledge and skills, but also necessary qualities that allow mastering new content, technologies, approaches, methods, subject areas and specialties [8].

Thus, training of a specialist in the era of digitalization should imply the implementation of training "for the future", "educating for the future use", with growth of not only competences of actual professional development of specialists, but also those additional "expected" competencies that one should possess, at least, at the end of the educational institution and at the stage of initial involvement in professional activities.

This approach removes the problem of "obsolescence" of professional competences received at the higher educational institution, makes it more adaptive not only to the current but also to the promising needs of the labor market and multiple demands of the employer.

Adherence to the concept of advanced education raises the need to match the content and nature of vocational education to the requirements of emerging trends in the creation of technical inventions and innovative technologies, advanced matching the number of trained highly qualified specialists to the emerging demand for them, the importance of obtaining better professional knowledge, skills and competencies of workers. At the same time, the most important direction in the development of education system in the era of digitalization is the improvement of information technology training of future specialists in a modern higher educational institution.

2. Problem Statement

Scientific research and practice show that today, the knowledge of information technologies and even the basic models of their application are not enough for an effective activity of a specialist. It requires new competencies, including critical and creative thinking, initiative and responsibility, adaptability, innovation and entrepreneurial approach, emotional intelligence, independence, ingenuity and organized nature.

These competences can be grouped in three blocks:

1. Digital competencies, that is, confident and effective use of information and communication technologies (ICT) for work, leisure and communication.
2. Initiative and entrepreneurial competences, that is, the ability to turn ideas into actions through creativity, innovation and risk assessment, and the ability to plan and manage projects.

3. Soft skills, or the ability to build intercultural network communications (social and professional), learn and improve, etc. [12].

Thus, educational trajectories are significantly changing today under the influence of the digital environment, taking into account the requirements for new professions and the people's values change, and orientation toward the applied science and practice is prevailing.

However, despite digital transformation of the educational process, changing forms, methods of teaching, and competences, classical fundamental education remains important for the formation of a modern system of higher education.

At the same time, scientists underline the importance of knowledge that future specialists should possess in programming, the development of modern students' abilities to interact with information systems and technologies, one's ability to engage an independent and productive dialogue with computers, make decisions and perform professional tasks, and manage complicated automated complexes (S.A. Beshenkov, T.A. Boronenko, O.V. Byakhov, A.G. Geyn, S.G. Grigorieva, V.A. Sukhomlin, etc.).

Therefore, it can be argued that the improvement of information technology training of future specialists in a modern higher educational establishment is the most important direction of the education system development in the era of digitization.

To solve this issue, it is necessary to systematize the principles for selecting the content of information technology training for higher educational establishments' students, taking into account the requirements of the FSES HE, domestic and foreign standards in the field of information technology, the concept of advanced education, and to develop a system of methodical and technological approaches to the improvement of information technology training using practice oriented and optimization approaches, e-learning, and distance education technologies.

3. Research Questions

3.1. Analysis of relevant theoretical, methodological and technological approaches to the issues of improving information technology training of students in a higher educational establishment.

3.2. Systematization of the principles of selection of the content of information technology training for higher educational establishments' students, taking into account the requirements of FSES HE, domestic and foreign standards in the field of information technology, as well as the concept of advanced education.

3.3. Development of a system of methodological and technological approaches to improving the information technology training of future specialists in the higher educational establishments using practice oriented and optimization approaches, advanced education and mixed-study technology.

4. Purpose of the Study

The purposes of this study are the following:

4.1 Substantiation of the need to improve the information technology training of bachelors and masters in the higher educational establishments as one of the components of the fundamental training of a modern specialist for Russian digital economy.

4.2. Development of a system of methodological and technological approaches to improving the information technology training of future specialists in the higher educational establishments.

5. Research Methods

In modern higher educational establishments, information technology training is an obligatory component of the educational process aimed at forming students' competences in the field of

informatics, information and communication technologies, information activities and information interaction.

The works of a number of researchers (T.M. Bannikova, N.A. Baranova, T.V. Ivanova, T.G. Kalinovskaya, S.A. Kosolapova, A.I. Kosolapov, N.I. Leonova, V.A. Sukhomlin, etc.) show that modern information technology training of students of higher educational establishments is distinguished by the following main features:

1. Information technology is not only an object of study, but means to change the educational process itself.
2. Rapid change of technologies and, as a result, rapid obsolescence of knowledge make it necessary to update IT-competencies reflected in the FSES HE and professional industry standards, at least, every 4 to 5 years [9].

These features of information technology training of a future specialist require from a modern university to cooperate closely with the labor market in order to promptly adjust the content of educational programs in accordance with employers' requests, as well as to follow the concept of advanced education [3], [4], [8].

At the same time, the most important requirement for the updated system of information and technological preparation of students is to preserve its fundamental nature that presupposes the following:

- Saturation of the content of education with new scientific information, facts and discoveries of Russian and foreign scientists in the relevant profile of training bachelors and masters in the areas of computer science, ensuring the compliance of the core of curricula with the guidance of the CC2001 (Computing Curricula 2001 Computer Science), SE2004 (Software Engineering 2004. Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering, CS2008 (Computer Science 2008), as well as professional standards in the field of information technologies used in the Russian Federation (recommended by the Association of Computer Enterprises and Information Technology);
- Creation of conditions for students to learn scientific and information base in order to effectively study computer disciplines, adaptability and replicability of educational technologies in combination with their stability and long-term, ensuring a reasonable balance between theoretical knowledge and applied technologies;
- Application of the achievements of modern teaching methods in the organization of information and technological training of students [6].

We cannot but agree with the statement of S.A. Kosolapova, A.I. Kossolapov, and T.G. Kalinovskaya that the fundamentals of information technology education of students in a university should be based on:

- The focus on ensuring a holistic perception of the scientific picture of the world,
- The disclosure of the essence of facts and phenomena from the field of profession and specialty,
- The ability to synthesize with knowledge from other areas (interdisciplinary knowledge),
- A high degree of universality, contributing to understanding and explaining the essence and interrelation of phenomena from different fields of science and practice,
- The focus on the intellectual development of a personality [9].

At the same time, the knowledge of natural sciences (higher and discrete mathematics, probability theory, mathematical statistics, computational methods and optimization methods) and technical sciences is fundamental for future IT specialists. Meanwhile, the principles of applying the obtained fundamental knowledge in practice are special knowledge serving as means of solving specific applied issues.

Therefore, when forming the content of information technology training for students, it is necessary to envisage the inclusion of disciplines and sections that ensure the formation of the following competencies:

- The ability to use the basic laws of natural science disciplines and modern information and communication technologies in professional activities;
- The formation of computer skills as a means of information management, including in global computer networks;
- The ability to design, develop, implement, and adapt application software, and conduct testing of components of information systems;
- The acquisition of experience in the survey of the IT activities and infrastructure of enterprises, in the research of the status and trends of the software market, selection of rational software packages and ICT solutions for business or enterprise management;
- The formation of skills in managing IT services and content of the enterprise.

The content of information technology training for non-core areas of the bachelor's program should, first of all, ensure the formation of experience in using subject-oriented and problem-oriented information technologies and information systems to solve tasks in the field of analytical, research, innovation, entrepreneurial and other activities. Therefore, in this case the content components of information technology education of students are aimed at the formation of the following competencies:

- The ability to manage information received from various sources using a computer;
- The ability to participate in the projects to modernize the IT infrastructure of the enterprise or the organization as a consultant;
- The experience in applying modern services and software packages to solve problems of educational and professional activity [5], [10], and [11].

On the basis of the foregoing, it can be concluded that, regardless the profile of the student's education, the content of information technology training in the higher educational establishments should be supported by academic disciplines on the basics of modern information technologies and academic disciplines of specific specialization (for specific IT sections).

Following S.A. Kosolapova, T.G. Kalinovskaya, V.A. Sukhomlin and other researchers, we believe that scientific knowledge introduced into IT disciplines should meet the information and developmental goals. They should also reflect the nature and dynamics of scientific and technological progress and the development of socio-economic processes, the principles of implementing “science-technology” links, the combination of professionally-oriented fundamental knowledge and new research technologies.

In our opinion, such an approach is justified, since it is maximally focused on the training of a specialist in demand by the labor market.

Thus, the fundamentalization of information technology training of specialists for the digital economy requires a revision of its content on the basis of a practice-oriented approach to the results of educational process aimed at the future professional activity of higher educational establishments’ graduates.

6. Findings

Below, we consider the proposed system of methodical and technological approaches to improving the information technology training of future specialists for the digital economy in higher educational establishments.

As noted above, in the system of higher education in Russia, there is a trend for and extensive use of methods of problem-oriented and project-organized training at all stages of mastering the profession. Our practice shows that the project-organized and problem-oriented activities of students,

ahead of independent work, and their participation in solving real problems contribute to the acquisition of skills and experience of practical use of fundamental knowledge, performing professional analysis, and carrying out research and design work by the future specialists.

Information about the subjects of IT projects carried out by students of Bryansk State University named after Academician I.G. Petrovsky provided in the Table 1 is the example of the implementation of a practice-oriented approach in the process of information technology education.

The subjects of the majority of final qualification works (FQW) of bachelors of the IT profile also have a pronounced practice-oriented applied character. This is the development of web-resources and web-services, development of mobile applications, creation of the automated information systems, etc. A number of FQWs are devoted to the development of information systems for individual entrepreneurs, small and medium-sized businesses (printing houses, car washes, shops, etc.), and innovative enterprises with subsequent implementation.

Table 1. Themes and types of the educational IT projects.

№	Project Types	Project Examples
1	Software Development Projects	Automation of <the process> on the example of <the organization name> Designing an information system of <the name of organization>
2	Applied projects	Development of a training application (desktop/mobile) on the topic <title> Web-service development <name>

It should be noted that in the practice of teaching information technology disciplines, the University's teachers widely introduce methods of active problematic, heuristic learning, in particular, a case-study method or a method of concrete situations, which has a number of features, such as:

- It is a kind of research analytical technology, includes operations of the research process and analytical procedures;
- It acts as a technology of team learning, the most important components of which are work in a group (subgroups), mutual exchange of information, and mutual evaluation;
- It is a specific type of project technology: within the case-study method, the problem is formulated, the ways of solving it are searched by using a “case” that serves both as a task and as a source of information for understanding the issue and selecting options for effective action.

Teachers of the University develop different types of cases and use them in the practice of teaching:

- Practical cases reflecting real life situations that a future specialist may face.
- Training cases, the main purpose of which is to solve educational problems by the students.
- Scientific and research cases focused on the research activities of the students. Such cases are a model for obtaining new knowledge about the situation, and how to behave in it.

It is worth noting that at the present time, against the backdrop of the continuous growth of scientific information in the field of information technologies and systems, there is also a problem of shortage of the time for study allocated to information technology disciplines. Therefore, we believe that in the process of improving the information technology training of university students, an optimization approach to teaching is required, which involves not only a revision of the content of training, but also the selection of optimal modern technologies and teaching methods.

Our analysis of current theoretical and methodological scientific publications, as well as the practice of our own work, show that at the current stage the primary role in achieving the above goals is played by e-learning, distance education technologies, active and interactive technologies and teaching methods, the use of which in the university's educational process allows creating conditions conducive to raising awareness, independence and activity in the future specialists study, and, as a consequence, the formation of a positive focus on their chosen professional field.

Today, the mixed education is the most popular and widely used model of e-learning with the use of distance education technologies in the system of higher education in Russia. The advantage of this model is that students receive and work out basic knowledge and skills using e-learning courses, and in the classroom they have an opportunity to gain deeper knowledge, and also to learn how to apply it under the guidance of a teacher.

The application of this model assumes the use of special software and hardware, the availability of special databases that store educational content and results of educational monitoring, substantial preparation of materials for independent study by the teachers, a thoroughly thought-out system of motivation and control, and an effective combination of the audience and network interaction of the actors of the educational process [7].

The following main components of the mixed training system can be distinguished:

1. The methodology (or model) of training reflects the purposes and tasks of training, the resulting requirements for the system, courses, implementation process, as well as performance metrics.
2. Learning Management Subsystem (LMS), that is, a set of software installed on the server in the local network of the educational institution or in the Internet, and providing the storage and delivery of e-courses to the trainees, the management of the training process, the automation of testing and certification of trainees, the formation of reports on the results of training, etc. The author's tools for the development of educational content is an obligatory element of this subsystem that provides creation of educational materials (electronic textbooks, presentations, simulators, video trainings, and tests), then placed in the LMS database. These include training courses editing tools, tools for creating presentations, tests and questionnaires, means for capturing images from the monitor, and means for conducting online seminars.
3. Training content, which is a content core of learning implemented through e-courses – the structured material on the topic or the discipline designed to solve pre-defined learning tasks.

The mixed teaching system used in the university's teaching process should correspond to the basic ideas and methods of didactics, such as:

1. Information-receptive methods of teaching: a short lecture, a short lecture for a group of listeners, a short lecture with a break, a lecture of the press conference type.
2. Methods of the problematic presentation: an interactive guide to studying the materials, a summary with questions, a critical perception of the materials, and “the listening groups”.
3. Heuristic teaching methods: “Free Group” discussion, controlled discussion, presentation of the chapter or the issue, making notes, checklists, and stimulation of questions.
4. Research methods of teaching, such as modeling, choice situations, “facts and conclusions”, and “reading, discussing, and reporting”.

The practice of our work shows that the choice of methods and forms of the mixed teaching is conditioned, first of all, by the content of the teaching materials and the aims of instruction. However, their use in the university's teaching process significantly enhances the student-centered direction of teaching through the organization of independent work of students at a particular pace and giving them an opportunity to communicate widely with other students and joint planning of their activities.

At the same time, one of the main requirements for the systems of mixed teaching is their interactivity that makes it possible to implement different models of interaction between subjects (man-man, man-group, and man-system) and assures mastering of the basic elements of the content of education, such as the knowledge and experience [7].

The interactive capabilities of programs and information delivery systems used in the mixed-teaching systems make it possible to establish and stimulate feedback, provide dialogue and constant support, that is, interactive interaction, which is impossible with the implementation of the majority of traditional teaching systems.

Among the technologies that make it possible to implement interactive training in the higher education institutions, we consider it necessary to mention the gaming technologies of teaching, which have an essential feature - a clearly stated goal and the corresponding result that is characterized by the cognitive orientation. Practice shows that the use of gaming technologies in the process of information technology training in the university is an undoubted plus in the motivational attraction of the current "playing" generation to the realities of the future profession.

We would like to emphasize the main points inherent to the gaming learning technologies:

- The immersion through the game components customary for students in the system of educational purposes, tasks, problems, and projects;
- The formation of professional values and development of the future specialist personality through specifically constructed game reality;
- The attitude towards mistakes (a student has the right to make mistakes), he/ she would not get a bad grade for a wrong answer; in this case, motivation is a kind of some reward, a teamwork, and involvement in training with the help of the game [13].

The practice of our work shows that a variety of educational games can be used for a number of disciplines that are studied within the framework of information technology training of future specialists at the higher educational establishments. There are many options, and one of them is creation of special gameplay courses using the most common tool - MS Power Point, which is well known to many teachers and students. When developing specialized electronic educational content, in addition to images and text, MS PowerPoint allows the course creator using the library of built-in shapes, animations, spectacular transitions, the functions of inserting video and audio materials into the presentation, not to mention hyperlinks and triggers. This is the powerful arsenal that enables the teacher to interact effectively with the student (player), not involving programmers to creation of the games-based course.

In the course of the pilot study to evaluate effectiveness of application of the developed methodological and technological approaches to improving the information and technological training of future specialists in the higher educational establishment using practice-oriented and optimization approaches and e-learning with the use of distance educational technologies, we registered a significant increase in the level of digital competencies (20% and more on average) of all students of the experimental sample (more than 150 students of the departments of physics and mathematics, natural sciences and geography, and economics).

7. Conclusions

The presented work substantiates the need to improve the information technology training of bachelors and masters in the higher educational establishments as one of the components of fundamental training of a modern specialist for the digital economy of Russia.

7.1. The authors systematized the principles of selecting the content of information technology training for higher educational establishments' students, taking into account the requirements of FSES HE, domestic and foreign standards in the field of information technology, as well as the concept of advanced education, the pursuit of which removes the issue of the "obsolescence" of professional knowledge and competences received in the university, makes the educational institution significantly more adaptive not only to the actual, but also the long-term needs of the labor market and the employers' multiple demands.

7.2. The analysis of relevant theoretical, methodical and technological approaches to the issues of improving information technology training of students in the higher educational establishments allows us stating that:

- Changing vector of the educational process from the knowledge-based approach to the practice-oriented approach to the results of the educational process, inevitably led to the formulation of

the problem of technologies and teaching methods by which this practice-orientation would be achieved;

- In modern conditions, active and interactive technologies and teaching methods play a primary role in improving training of bachelors and masters in the higher educational establishments, as well as the use of distance education technologies in the modern information and educational space of the university on practice, which allow developing such areas as electronic and mixed training, create conditions that increase awareness, independence, activity of educational efforts of the future specialists and, therefore, the formation of their positive focus on selected professional activities.

7.3. The paper presents a system of methodical and technological approaches to improving the information technology training of the future specialists at the higher educational establishments using practice-oriented and optimization approaches, advanced education and the mixed-study technology, which is based on the implementation of a complete interactive dialogue with the use of interactive learning tools based on modern information technologies, gaming technologies and distance learning technologies.

Practical implementation of the system of methodical and technological approaches to improving information technology education of students of a modern university proposed by the authors will help increasing information competences, personal and professional development and self-development of the university students as subjects of digital economy that would possess competitiveness on the labor market.

References

[1] Government of the Russian Federation 2017 *The program "Digital Economy of the Russian Federation", approved by the decree of the Government of the Russian Federation of July 28, 2017 No. 1632-p (*http://static.government.ru/media/files/9gFM4FHj4PsB79I5v7yLVuPgu4bvR7M0.pdf)

[2] Internet portal of legal information 2014 *Strategy of scientific and technical development of the Russian Federation* (http://publication.pravo.gov.ru/Document/View/0001201612010007)

[3] Andropova E V and Suhomlin V A 2013 Diversification of professional training programs in international educational standards in the field of information technology *Bulletin of Moscow University. Series 20: Pedagogical Education* **1** pp 73-86

[4] Byakhov O V 2005 *The role of IT education in the development of the information society* (http://www.it-education.ru/2005/reports/1_Byahov.htm)

[5] Eliseeva E V, Ivanova N A and Trubnikov S V 2017 Improvement of information technology training of students of the University *Applied and Fundamental Studies: Proceedings of the 13th International Academic Conference* pp 109-113

[6] Eliseeva E V, Ivanova N A and Malinnikov S G 2018 Perfection of information and technological preparation of university students on the basis of practical-oriented and optimization approaches in teaching *Problems of Modern Pedagogical Education* **59** *(p. III)* pp 266-269

[7] Eliseeva E V and Petukhova L P 2017 Implementation of interactive learning in higher education *Problems of Modern Pedagogical Education. Series: Pedagogy and Psychology 5.5 (p. IV)* pp 168-175

[8] Zlobina S N, Eliseeva E V, Savin A V, Stepchenko I G, Shadoba E M 2016 Informatization as a priority direction of modern higher professional education *Problems of Modern Pedagogical Educatio*n **50**(4) pp 138-144

[9] Kosolapova S A, Kalinovskaya T G and Kosolapov A I 2013 To the question of the fundamentalization of engineering education *Advances in Modern Natural Science* **6** pp 134-136

[10] Kupriyanovsky V P, Sukhomlin V, Dobrynin A, Raikov A, Shkurov F, Drozhzhinov V,

Fedorova N, Namiot D 2017 Skills in the Digital Economy and Challenges of the Educational System *International Journal of Open Information Technologies* **5**(1) pp 19-24

[11] Prozorova G V 2013 Structuring the content of the profile preparation of future IT specialists in the form of training modules *In II All-Russian Scientific-Practical Conference "Information Technologies in Science and Education"* (http://chb.ito.edu.ru/2013/section/190/93891/)

[12] Shmelkova L V 2016 Personnel for the digital economy: A look into the future *Additional Vocational Education in the Country and in the World* **8**(30) pp 1-4

[13] Eliseeva E V, Zyateva L A, Kiyutina I I, Weiler V P, Shkityr O N, Isakova G S 2017 Gamification technology in the higher school *Applied Business and Economic Research* **15**(11) pp 175-183