

Mismatch between the Level of Training of IT Personnel and the Requirements of Employers: Problems and Solutions



**Yuliya O.
KLIMOVA**

Vologda Research Center, Russian Academy of Sciences

Vologda, Russian Federation

e-mail: j.uschakowa2017@yandex.ru

ORCID: 0000-0002-3295-9510; ResearcherID: Q-6340-2017



**Kseniya A.
USTINOVA**

Vologda Research Center, Russian Academy of Sciences

Vologda, Russian Federation

e-mail: ustinova-kseniya@yandex.ru

ORCID: 0000-0002-6198-6462; ResearcherID: I-8164-2016

Abstract. The availability of qualified IT specialists is an important factor that contributes to the development of the digital economy. The need for personnel training for the IT industry is stated in the national project “Digital economy of the Russian Federation until 2024”. Educational organizations are an important source that supplies IT specialists for the economy. However, today there is an acute problem of inconsistency between the educational system and the labor market. The aim of the study is to identify problems of non-compliance of the level of IT personnel training with the requirements of employers, and to determine ways to address these problems (on the example of the Vologda Oblast). Using the data from the Ministry of Science and Higher Education of the Russian Federation, we analyze the number of graduates in information technology-related fields in the Vologda Oblast. We also review educational programs at universities of the region and reveal problems in the formation of professional

For citation: Klimova Yu.O., Ustinova K.A. Mismatch between the level of training of IT personnel and the requirements of employers: Problems and solutions. *Economic and Social Changes: Facts, Trends, Forecast*, 2021, vol. 14, no. 5, pp. 202–219. DOI: 10.15838/esc.2021.5.77.12

competencies in students. Based on the results of a survey conducted in 2020 by VoIRC RAS, we have obtained information on the compliance of the level of competencies in graduates of IT specialties with the requirements of employers in the IT industry. In the final part of the article we highlight problems related to personnel training for the IT industry of the region and outline main ways to address them. Scientific novelty of our work consists in the application of a system-wide approach that help us study the viewpoints widespread in the education system and among employers, in order to identify problems related to the training of in-demand personnel for the IT industry. The materials of our study can be used by researchers, postgraduates and students who deal with the issues of digital economy development and those related to the staffing of this industry. Practical significance of our work lies in the fact that our proposals for solving the problems under consideration can be used by federal and regional authorities and management bodies, when it would be necessary to adjust plans for the implementation of national projects “Digital economy” and “Education”; our proposals should also be the basis for goal-setting and reflected in the tasks of other regulatory documents in the field of education at the federal and regional levels.

Key words: digital economy, region, IT industry, IT personnel, IT personnel training.

Introduction

Currently, the transition to a digital economy is a global trend that sets out directions for the development of various economy sectors of all countries. The focus on digitalization is driven by the need to improve the competitiveness of the economy, as well as the population living standards [1; 2; 3]. In Russia, the digitalization of socio-economic processes is determined by the goals and objectives outlined in the passport of the national program “Digital Economy of the Russian Federation”, which prioritizes the creation and use of information technology (hereinafter – IT), such as artificial intelligence, internet of things, robotics, etc.¹ The need to develop the information technology industry (hereinafter – IT industry) as one of the prevailing conditions for digitalization is noted in the Strategy of the Information Society Development in the Russian Federation for 2017–2030². These circumstances indicate that the

development of the IT industry is the main factor in the transition to a digital economy in the country and the world.

It is worth emphasizing that the current level of informatization in Russia differs significantly from that in other countries. This fact is confirmed by data from various international rating agencies on the functioning of the IT industry. Despite the slight difference in the data, we can note that the leaders on the way to the information society are Singapore, Denmark, Sweden, and the Netherlands³. According to international ratings, Russia is 1.5–2 times behind the leading countries, and the gap increases every year⁴. For example, according to the World

¹ Passport of the national program “Digital Economy of the Russian Federation”. Available at: <https://digital.gov.ru/ru/activity/directions/858/>

² “On the Strategy of the Information Society Development in the Russian Federation for 2017–2030”: Presidential Decree no. 203, dated May 9, 2017. Available at: <https://www.garant.ru/products/ipo/prime/doc/71570570>

³ It is difficult to analyze the data of international rating agencies in dynamics, because the methodology for calculating the Networked Readiness Index has changed since 2019. Therefore, the earlier data are not comparable with the current data. The table shows the index values for 2019 and 2020 for a uniform presentation of information from different international rating agencies.

⁴ Networked Readiness Index 2019–2020. Available at: https://networkreadinessindex.org/wp-content/uploads/2020/11/NRI-2020-V8_28-11-2020.pdf; World Digital Competitiveness Ranking 2020. Available at: file:///C:/Users/user/Downloads/digital_2020.pdf; The Global Competitiveness Report 2020. Available at: <https://gtmarket.ru/ratings/imd-world-competitiveness-ranking>

Digital Competitiveness Ranking, in 2020, Russia has dropped three positions compared to 2019⁵.

It can be assumed that the reason Russia lags behind other countries is the lack of IT specialists. Various factors affecting the development of the IT industry are mentioned in the scientific literature, including financing, the cost of infrastructure, government policy, the taxation system, etc.⁶ [4; 5; 6]. At the same time, a significant part of researchers notes that to a greater extent the development of the IT industry is influenced by such a parameter as the availability of qualified IT specialists [7–10]. However, the analysis of various sources shows that there are two main approaches concerning the nature of staff impact on the development of the IT industry. The first is that the effective development of the IT industry depends on staffing (A.A. Safronova [4], I. Agapov [10], G.V. Zinenko [9], etc.). Representatives of the second approach, on the contrary, note that the shortage of qualified staff does not hinder its functioning (S. Akhmetov⁷, Yu. Krasil'nikova⁸, etc.). Despite the fact that the second approach is less common among researchers, the existence of opposing opinion indicates the debatable nature of the issue being raised.

The globalization of markets affects the increasing speed of technology diffusion, which, in turn, intensifies the processes of modernization of traditional industries, including the creation of new ones. All this leads to the emergence of new professions, areas of activity and leads to increased demand for qualified specialists. Currently, staffing becomes one of the main conditions for

the development of the IT industry and the digital economy as a whole. However, according to the specialists of the Information and Computer Technologies Industry Association (hereinafter APKIT), the proportion of IT specialists among the employed population in Russia as of 2019 was 2.4%. According to this indicator, the country is 1.5–3 times behind the world leaders⁹. According to the information provided by an online recruiting company, only 1.7 people apply for one vacancy, with the optimal situation when there are 4–5 resumes per vacancy and the employer has the opportunity to select the best candidate¹⁰. This situation indicates a low supply of labor and a high demand for IT specialists on the part of business. Under these conditions, according to available data, from 2010 to 2017 the number of IT specialists remained unchanged (growth was only 0.09%). APKIT experts estimate that by 2024 the demand for IT specialists will be 290–300 thousand people a year¹¹.

The current situation indicates the low staffing level in the IT industry, so the problem of training IT specialists becomes extremely relevant in the transition to a digital economy, both at the federal and regional levels, which determines the practical relevance of our study.

The purpose of the study is to identify problems of mismatch between the level of IT personnel training and the requirements of employers and to identify areas to address them (in the case of the Vologda Oblast). To achieve the goal, we addressed the following tasks: 1) to study the trends in IT personnel training in the Vologda Oblast universities; 2) to analyze educational programs of the Vologda Oblast universities in IT-related training fields; 3) to assess employers' satisfaction with the level of IT specialists training in the Vologda Oblast

⁵ World Digital Competitiveness Ranking 2020. Available at: file:///C:/Users/user/Downloads/digital_2020.pdf

⁶ Dynamics and prospects of IT industry development. Available at: <https://issek.hse.ru/news/371816718.html>

⁷ Akhmetov S. IT staff shortage: why Russia does not have enough IT pros and where to find them. Available at: <https://yandex.ru/turbo/hightech.fm/s/2020/02/17/hr-it-russia>

⁸ Krasil'nikova Yu. 84% of Russian companies experience an acute shortage of personnel. Available at: <https://hightech.plus/2018/12/04/rossiiskie-kompanii-gotovi-platit-it-specialistam-do-1-mln-rublei-v-mesyac>

⁹ Association APKIT. Available at: <https://zsrfr.ru/directway/2020/01/27/trebujutsja-itshniki-mnogo>

¹⁰ HeadHunter Index. Available at: <https://stats.hh.ru/>

¹¹ Association APKIT. Available at: <https://zsrfr.ru/directway/2020/01/27/trebujutsja-itshniki-mnogo>

universities (according to the survey); 4) to highlight problems and outline directions to promote IT personnel training.

Scientific novelty of our work lies in the application of a system-wide approach that help us study the viewpoints widespread in the education system and among employers, in order to identify problems related to the training of in-demand personnel for the IT industry. Its use involved a reference to various sources of information, such as the data of the Ministry of Science and Higher Education of the Russian Federation, educational programs of universities in the Vologda Oblast, as well as the results of a survey among employers of IT companies.

Theoretical aspects

The role of personnel in the development of the IT industry is noted both among experts and in scientific literature. For example, experts of the Internet Initiatives Development Fund point out that in the next 10 years, as a result of the large-scale digitalization of industries, the need for IT specialists will grow¹². Employees of the Agency for Strategic Initiatives (hereinafter – ASI) emphasize that the availability of professionals with IT competencies is an important factor on which the effective functioning of the IT industry depends¹³. The role of personnel in the implementation and use of IT is also discussed in [8; 11]. As emphasized in the studies [9; 10], the impact of the national project “Digital Economy” on the need for IT specialists is obvious, because IT development is rapid and

it is used in different segments. The prevalence of these processes strengthens the role of personnel specializing in different areas of IT.

Before proceeding to consider the problem of staffing, it is necessary to indicate how this concept is interpreted in scientific works. The results of our study [12] show that there are two main approaches to the concept of staffing among experts – resource-based and process-based (*Tab. 1*).

In accordance with the purpose and objectives of the work, we take into account the concepts of both approaches. One should note that the process is a specific sequence of steps aimed at achieving a result. In this regard, the professionalism and competence of the trained specialist depends on how effectively personnel training activities will be organized, which determines the need to use the concepts of the process-based approach. On the other hand, resource provision, in particular personnel, will affect the dynamics of the IT industry. In this case, it is important to adhere to the concepts of the resource-based approach.

As mentioned above, the transition to a digital economy requires qualified IT specialists. The problem of staff shortage is being discussed at the state level, as well as among experts. In this regard, it seems reasonable to consider how Russian IT business representatives themselves assess the staffing level. The analysis allowed distinguishing three main approaches. The first approach considers the supply of specialists, paying attention to the existing staff shortage in the IT industry. The second

Table 1. Approaches to defining the concept of staffing

Approach	Content of the approach
Process-based	A time-consuming process that is carried out using a set of methods and tools for training and providing them to organizations, in accordance with the needs of the economy (S.A. Spilberg, N.M. Antoshina, O.V. Basharina)
Resource-based	One of the main resources that allow production to function and meet the quantitative and qualitative characteristics of the needs of organizations (O.V. Binert, N.Y. Anisimova, N.N. Barchan, A.A. Kotov, A.P. Chumachenko)
Compiled according to: [13–17].	

¹² Human resources in the age of digital economy. *RIA Novosti*. Available at: <https://ria.ru/20191230/1562653998.html>

¹³ Atlas of Emerging Jobs. Available at: https://www.skolkovo.ru/public/media/documents/research/sedec/SKOLKOVO_SEDeC_Atlas.pdf

approach is based on the demand for IT personnel, which is connected not so much with the shortage of specialists as with the lack of jobs for them. Representatives of the third approach say that it is impossible to unambiguously assess staffing [10].

The study of approaches showed the highest prevalence of the first position, which is associated with a lack of IT specialists to implement the changes, their inadequacy to meet the requirements of employers. It is worth noting that this point of view is confirmed by the use of indicators. In the course of the study we found that the main indicator, which allows assessing the staffing level, is the ratio of the actual number of specialists to the planned need [12]. Internet recruitment company data show that demand exceeds supply twofold, and that there is an increase in the need for personnel. If in 2019 APKIT experts estimated the need for personnel by 2024 at 290–300 thousand people a year, in 2021 the deputy head of the Ministry of Digital Development, Communications and Mass Media reported that the shortage of IT specialists has already reached 500 thousand to 1 million people a year¹⁴. Thus, with the dynamic development of the IT industry, with continuing trends, the problem of a shortage of specialists will be exacerbated.

Educational organizations are an important source of human resources reproduction. However, today they do not cope with the task effectively enough, as evidenced by the opinions of representatives of the IT business, universities and other experts. According to the head of an IT company, today there is a lack of graduates in IT-related professions. In addition, educational institutions give students only the basics (often outdated)¹⁵. This point of view was also expressed by a specialist from another IT organization,

¹⁴ Russia has a severe shortage of IT specialists. Available at: https://www.cnews.ru/news/top/2021-02-17_v_rossii_katastroficheskij

¹⁵ On the situation with the shortage of IT staff. Figures and facts. Available at: <https://www.itweek.ru/business/article/detail.php?ID=209736>

which noted that universities acquire only basic knowledge, which is insufficient to solve current professional problems¹⁶. The results of the auditing company¹⁷ study show that among the main barriers for companies ready for digitalization are the lack of necessary competencies and the lack of IT literacy in employees¹⁸.

Despite the presence of a large number of scientific studies devoted to the topic of imbalance between the educational system and the labor market, there are still debatable aspects [18–21]. For example, A.N. Kochetov, Doctor of Sciences (History), Professor at the Department of Sociology and Public Relations of Saratov State Social and Economic University, notes that there is no complete clarity about the imbalance, there are different assessments of the situation. In some cases, personnel shortages are attributed to a reduction in the workforce. In addition, arguments prevail that specialists with higher education diplomas are in sufficient demand and their need is determined by the nature of the current Russian economy¹⁹. While there is a gap between the needs of employers and the skills of students and graduates, it is not severe²⁰. G.A. Klyucharev and Yu.V. Latov emphasize: it is impossible to say that the situation concerning the correspondence of the received knowledge to the employers' requirements is very bad, only every fourth university graduate doesn't work in the specialty they have been trained in [22]. The

¹⁶ IT specialists are indeed in short supply. Available at: <https://vc.ru/hr/107883-it-specialistov-deystvitelno-ne-hvataet-eksperty-rasskazali-o-sprose-na-it-specialistov>

¹⁷ KPMG is one of the world's "Big Four" accounting firms. The acronym in the organization's name consists of the first letters of the last names of the founders of the independent accounting firms that joined KPMG.

¹⁸ Digital technologies in Russian companies. KPMG research, 2019. Available at: <https://assets.kpmg/content/dam/kpmg/ru/pdf/2019/01/ru-ru-digital-technologies-in-russian-companies.pdf>

¹⁹ Kochetov A.N. Vocational education and the labor market: problems of interaction. Available at: <http://ecsocman.hse.ru/data/2011/09/20/1267450955/Kochetov.pdf>

²⁰ Race for personnel. Available at: <https://spb.plus.rbc.ru/news/5afbcf187a8aa93e43d3c4ba>

presence of different points of view determines the scientific significance of the conducted research.

The variety of approaches suggests that there is no consensus on the problem of a qualitative and quantitative gap between the demand for IT personnel and their supply both on the part of educational institutions and the labor market. This actualizes the need for further research in this area; in this regard, consideration of the problems of training IT specialists is extremely important. As the study of theoretical aspects showed, despite the relevance of the issues of staffing of the IT industry, there are not many scientific works on this topic, especially related to the regional level. The issue is mostly raised in the authorities and among representatives of IT companies. Consequently, our research contributes to the study of the problems of staffing as such. In addition, its results can be used in the study of this issue at the regional level.

Methods and information base of the study

In order to implement the purpose and objectives of the study, we used a systematic approach, which consisted in a comprehensive study of the problem raised. For this purpose, we presented theoretical aspects of the problem of staffing, analyzed trends in the training of IT specialists from the quantitative and qualitative side, considered the issues of IT staff qualifications compliance with the requirements of employers, and highlighted the main problems of training for the IT industry and directions for their solution.

We used a combination of scientific methods to conduct the study. Using the statistical method, we analyzed the number of IT graduates. In order to identify common and different features in the change in the number of graduates at different levels of education (bachelor's degree, specialist degree, master's degree), as well as to compare training areas related to IT, we used the method of comparative analysis. Along with this, the method of comparative analysis was used to review scientific literature in the study of theoretical and

methodological aspects of the problem under consideration. The method of empirical research, based on the survey (questionnaire), was used to obtain information about employers' satisfaction with the competence level of IT specialties graduates. Based on the methods of generalization and synthesis, we identified the problems that exist in the training process for the IT industry.

The data of the Ministry of Science and Higher Education of the Russian Federation (the number of graduates in IT-related fields in the Vologda Oblast) served as the information base for the study. The information provided by the Ministry includes the period from 2013 to 2019, which limits the possibilities for comparative analysis. In addition, to study the problems of forming students' professional competencies, we used undergraduate and graduate educational programs in IT training areas, published on the websites of Vologda State University (VSU) and Cherepovets State University (ChSU). Their analysis was based on available data for the period from 2016 to 2018. Also, in order to obtain information on the compliance of the competences' level of IT specialties' graduates with the requirements of employers, we used the results of the survey of IT company managers²¹.

The choice of the object of our research is due to the fact that the Vologda Oblast is a typical region of the Russian Federation in terms of readiness to the information society. In 2016, the Ministry of Digital Development, Communications and Mass Media, as part of the study of information society development in the regions of the Russian Federation, for the first time published a rating of the subjects by the level of informatization. In 2017, a comparative rating was presented, according to

²¹ The survey was conducted in 2020 by the Vologda Research Center of the Russian Academy of Sciences. A list of IT-companies of the Vologda Oblast was compiled for monitoring on the basis of OKVED (61. Activity in the field of telecommunications; 62. Development of computer software, consulting services in this area; 63. Activities in the field of information technologies).

which more than half of the regions of the Russian Federation showed an increase in the values of the index of readiness to the information society²². The Vologda Oblast took an average position in terms of readiness to the information society, the index values increased only in one year. Since the rating data have not been updated over the past 2–3 years, our study will be based on the available data.

In addition, according to the information of the Internet recruiting company, 82% of employers in the IT field are looking for specialists mainly with a completed higher education [12], in this regard the problems of personnel training in the Vologda Oblast are considered on the data of educational institutions of higher education.

Research results

One should note that the situation at the regional level is similar to that at the federal level. The Vologda Oblast is also experiencing a serious lack of personnel in the IT industry. In 2018, this indicator was one and a half times lower than the Russian average. For the period from 2010 to 2018, the number of IT personnel remained virtually

unchanged (growth by 0.29 p.p.). In conditions of high demand, the problem of IT-specialists shortage is most acute. One of the sources of staff reproduction is educational organizations. The need for IT specialists influences the increase in demand for graduates in IT-related fields of study.

Analysis of the data of the Ministry of Science and Higher Education of the Russian Federation (hereinafter – the Ministry) showed that the Vologda Oblast universities train personnel in only eight IT areas, while in the Russian Federation there are 12 such areas. Despite the course taken in 2016–2017 to build a digital economy in the country, training in a number of areas has ceased. For example, the Vologda Oblast universities did not conduct training in “Business informatics”, “Infocommunication technologies and communication systems” (internal study mode) in 2019, while it was previously conducted. There is a decrease in the number of undergraduate graduates in such educational programs as “Applied mathematics and computer science” (7%), “Applied computer science” (27.3%), “Business informatics” (72.4%), etc. (Tab. 2).

Table 2. Number of graduates from educational organizations of the Vologda Oblast in IT-related bachelor's degree programs, people

Educational program	2013			2015			2017			2019		
	e	i	m	e	i	m	e	i	m	e	i	m
Applied mathematics and computer science	-	0	-	-	14	-	-	9	-	-	13	-
Business informatics	-	0	-	-	29	-	-	8	-	-	-	-
Applied computer science	0	0	-	0	11	-	8	0	-	9	8	-
IT security	-	0	0	-	6	18	-	15	-	-	14	-
Information and communications technologies and communication systems	-	0	0	-	0	0	-	9	0	-	-	-
Computer science and engineering	0	0	-	26	22	-	35	21	-	34	24	-
Information systems and technologies	0	0	0	-	35	0	-	16	6	-	16	-
Software engineering	-	0	-	-	15	-	-	15	-	-	14	-
Total	0	0	0	26	132	18	43	93	6	43	89	-

Note: e – external study mode; i – internal study mode; m – mixed attendance; 0 – no graduates; “–” – training in this field was not conducted (here and in Tab. 3–4).
Compiled according to: data from the Ministry of Science and Higher Education of the Russian Federation. Available at: <https://www.minobrnauki.gov.ru/ru/activity/stat/highed/index.php> (here and in Tab. 3–4).

²² On monitoring the development of the information society in the constituent entities of the Russian Federation. Ministry of Digital Development, Communications and Mass Media. 2017. Available at: http://tomedu.ru/wp-content/uploads/2015/02/Vopros_8_Rejting.pdf

Master's degree students in the Vologda Oblast were trained in only four IT disciplines on an internal study mode basis. The number of graduates increased by 63.6% over 2013–2019. In the context of specialties, their growth is also observed, except for “Applied mathematics and computer science” (decline by 27.3%; *Tab. 3*).

The training of IT students in the Vologda Oblast universities was also carried out only on an internal study mode basis in three areas and only through to 2015, while the total number of graduates decreased by 47% (*Tab. 4*). The decrease in the number of specialists is associated with Russia's transition to the Bologna system of education, which caused a decrease in the admission quotas for specialist degree programs. According to enrollment campaigns, since 2015 the Vologda Oblast universities have not recruited applicants for specialist degree programs in IT-related fields, so the reduction in the number of specialist degree graduates is associated with the graduation of students from the previous years and the lack of new applicants.

The proportion of IT training areas in the total number of all specialties in the Vologda Oblast universities remains at a low level, despite an

insignificant growth from 2013 to 2019. Thus, in 2019 the proportion of IT directions from all educational programs in the Vologda Oblast was 4.1% (external study mode), 9.4% (internal study mode) and was absent in mixed attendance mode.

Thus, the data of the Ministry show that there are problems in the system of training of specialists for the IT industry in the Vologda Oblast. First, the processes of digitalization and IT diffusion are characterized by the emergence of new professions, which imposes requirements for the emergence of new areas of training in educational organizations. However, during the period under consideration the list of IT specialties in the region's universities has not undergone any changes. Second, despite the growing demand for IT specialists, their training stopped in such undergraduate areas as, for example, “Business informatics” and “Information and communications technologies and communication systems”. Third, the proportion of training areas for the IT industry in the total volume of all specialties is extremely small. Given the decrease in the number of graduates in the IT field, as well as the above-mentioned factors, the current situation indicates the inability of the education system to cover the growing demand for IT specialists.

Table 3. The number of graduates from educational organizations of the Vologda Oblast in IT-related master's degree programs, people

Educational program	2013			2015			2017			2019		
	e	i	m	e	i	m	e	i	m	e	i	m
Applied mathematics and computer science	-	11	-	-	9	-	-	14	-	-	8	-
Computer science and engineering	-	8	-	-	8	-	-	14	-	-	10	-
Information systems and technologies	-	3	-	-	5	-	-	10	-	-	6	-
Software engineering	-	0	-	-	6	-	-	2	-	-	12	-
Total	-	22	-	-	28	-	-	40	-	-	36	-

Table 4. The number of graduates from educational organizations of the Vologda Oblast in IT-related specialist degree programs, people

Educational program	2013			2015			2017			2019		
	e	i	m	e	i	m	e	i	m	e	i	m
Applied mathematics and computer science	-	25	-	-	17	-	-	-	-	-	-	-
Applied computer science	6	32	-	-	-	-	-	-	-	-	-	-
Information systems and technologies	-	11	-	-	19	-	-	-	-	-	-	-
Total	6	68	-	-	36	-	-	-	-	-	-	-

Along with the shortage of IT personnel, the problem associated with the quality of their training is widespread. This is evident from the analysis of the formation of students' professional competencies, which was carried out with the use of educational programs on IT directions of universities in the Vologda Oblast. The methodology and stages of the analysis of educational programs were presented earlier [23].

The results of the analysis of undergraduate educational programs in IT training areas of universities in the region indicate the greatest emphasis on the development of competencies of design and industrial-technological (service-operational) activities. This is confirmed by the fact that each of the educational programs of the

Vologda Oblast universities accounts for more than 37.8% of the hours aimed at developing the professional competencies of this group from all other groups (with equal development – 33%). At the same time, a number of educational programs lack the focus on the formation of analytical and organizational-managerial activity competences (Tab. 5). This indicates that there are prerequisites for unequal development of different groups of professional competencies among students of the Vologda Oblast universities.

An important aspect in the process of specialist training is practice as an opportunity to implement the knowledge obtained in the university. A significant part of the educational programs for IT training areas of universities in the Vologda Oblast

Table 5. Overview of educational programs in IT specialties in universities of the Vologda Oblast (bachelor's degree)

University	Educational program	PCG1, %	PCG2, %	PCG3, %	Proportion of practice in disciplines with PC*, total, %
01.03.02 Applied mathematics and information technologies					
VSU	Applied mathematics and information technologies	58.5	41.5	0.0	25.1
ChSU	Mathematical and information support of socio-economic processes	75	0	25	14.0
09.03.01 Information technologies and computer science					
VSU	Computers, complexes, systems and networks	46.7	53.3	0.0	13.7
	Software for computer facilities and automated systems	52.0	48.0	0.0	10.2
09.03.02 Information systems and technologies					
VSU	Information systems and technologies	26.9	59.0	14.1	11.2
ChSU		10.7	89.3	0.0	15.4
09.03.03 Applied information technologies					
VSU	Applied information technologies in economics	18.6	44.1	37.3	15.4
09.03.04 Software engineering					
VSU	Software and information systems development	37.8	37.8	24.3	14.8
ChSU		53.7	39.0	7.3	23.0
10.03.01 Information security					
ChSU	Security of computerized systems	21.9	56.3	21.9	14.0
11.03.02 Communication technologies and systems					
ChSU	–	11.6	55.8	32.6	15.8
<p>Note: PCG1 – competencies of research (experimental) activities; PCG2 – competencies of design, production and technological activities; PCG3 – competencies of analytical, organizational and managerial activities. * The proportion of hours of practical classes that develop professional competencies (PC) of the student, from the total number of hours of an educational program (here and in Tab. 6). Compiled according to: Information about educational programs of VSU. Available at: https://vogu35.ru/sveden/education. Information about educational programs of ChSU provided by official request.</p>					

has a low degree of practice orientation – the proportion of training hours is less than 16.7%²³.

A similar situation is observed in the master's program, the only exception is the development of competencies of research (experimental) activities (more than 47.8% of academic hours). This correlates with the objectives of the master's degree to form theoretical knowledge and skills of research activities. A number of educational programs of master's degree, as well as bachelor's degree are less related to the development of competencies of analytical, organizational and management activities. There is also a low level of practice orientation. Only one ChSU program 09.04.04 "Software and information systems development" has a high degree of practical orientation compared to the rest (37.4%; *Tab. 6*).

Thus, the study of the qualitative side of IT specialist training on the basis of educational programs in IT areas of universities in the Vologda Oblast allowed concluding the following. First, there is an uneven distribution of opportunities for the formation of students' professional competencies in different groups. If at the undergraduate level

the emphasis is made on the development of design and production-technological (service-operational) competences, then at the master level – on the research (experimental) ones. At the same time, the competences of analytical and organizational-management activity are developed to a lesser degree both in bachelors and masters.

Second, the master's degree allows deepening of specialization in the chosen direction, if it does not change after studying at the bachelor's degree [24]. However, in the context of entering a master's program in another direction, the continuity between educational programs is violated and the master's program cannot form all the necessary professional competencies in two years [23].

Thirdly, there is a low level of practice-oriented educational programs in the IT areas of universities in the Vologda Oblast, both in the master's and bachelor's degree programs.

These problems are identified as a part of a system-wide approach, considering different positions. In educational organizations students are given basic knowledge in a particular specialty, which is deepened in the work activity, specific

Table 6. Overview of educational programs in IT specialties of Vologda Oblast universities (master's degree)

University	Educational program	PCG1, %	PCG2, %	PCG3, %	Proportion of practice in disciplines with PC*, total, %
01.04.02 Applied mathematics and information technologies					
VSU	Mathematical modeling	28.6	39.3	32.1	9.8
09.04.01 Information technologies and computer science					
VSU	Distributed and automated systems	59.3	40.7	0.0	6.7
	Control and computing systems	100.0	0.0	0.0	5.9
09.04.02 Information systems and technologies					
VSU	Multimedia technologies	47.8	32.6	19.6	10.6
09.04.04 Software engineering					
VSU	Software and information complexes	52.9	47.1	0.0	5.0
ChSU	Software and information systems development	64	36	0	37.4
Compiled according to: Information about educational programs of VSU. Available at: https://vogu35.ru/sveden/education . Information about educational programs of ChSU provided by official request.					

²³ In the educational programs about 50% of the academic hours of the discipline is allocated for independent work, and the remainder is evenly distributed on classroom lessons – lectures, practice and laboratory. Based on this, it can be assumed that the disciplines in which more than 25% of the academic hours are devoted to practical classes, have a high degree of practice-oriented, from 25 to 16.7% – average, and less than 16.7% – low.

skills are acquired according to the requirements of a particular enterprise. In this regard, based on the survey conducted in 2020 by VolRC RAS, it seems reasonable to consider how the knowledge and skills obtained in the Vologda Oblast universities are evaluated by employers in the IT area.

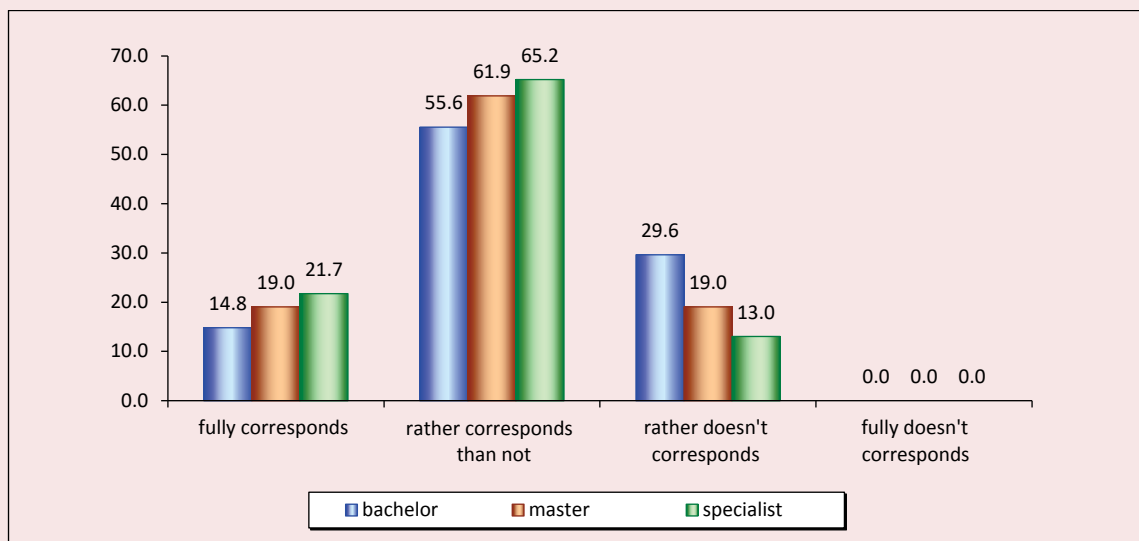
Thus, the heads of IT companies in the Vologda Oblast were asked to assess the degree of conformity of knowledge and competencies of the personnel who completed their training (bachelor's degree, master's degree, specialist degree) in the universities of the Oblast, employed over the past two years. Almost one third of the respondents are inclined to believe that the degree of IT specialist's qualification "rather does not correspond". A similar position is common among those who hired bachelors – 29.6% (Fig. 1). Respondents most highly evaluated the qualification of IT specialist – graduate with a Specialist Degree. Thus, 65.2% of the respondents indicated that their qualification "rather corresponds than not", 21.7% – "fully corresponds". The quality of

knowledge of specialists is the most appreciated by employers. However, in the last few years the Vologda Oblast universities do not recruit applicants for specialist programs in IT.

The survey conducted among managers of IT companies made it possible to assess the development level of different groups of professional competencies of Vologda Oblast universities graduates from the point of view of employers. The development of competencies of analytical activity was evaluated by every fifth person with 3 points, 17.2% with 4 points on a ten-point scale. The responses about the level of development of organizational and managerial competences were similarly distributed. Every fourth has assessed them as 4 points, 17.7% of the respondents – 3 points.

Every third respondent described the level of development of project activity competencies as 4 points. Every fifth IT-company manager assessed the level of development of R&D competencies as 5 points, the same proportion of respondents gave 7

Figure 1. Distribution of answers to the question "How would you assess in general the extent to which the qualifications of an IT specialist (graduate of a Vologda Oblast university) meet the requirements of the workplace of your organization?", % of respondents



Source: own compilation according to the survey results.

Table 7. Distribution of answers to the question about assessing the level of graduates' development of different groups of professional competencies, % of respondents

Professional Competence Group	Point									
	1	2	3	4	5	6	7	8	9	10
Analytical competencies	0	0	19.0	17.2	10.5	13.8	15.7	17.0	3.4	3.4
Organizational and managerial competencies	0	0	17.7	24.3	15.6	10.3	13.8	10.0	4.9	3.4
Project activity competencies	0	0	3.0	27.6	14.0	10.3	17.2	17.0	6.9	3.4
Competencies of research (experimental) activities	0	0	3.0	17.3	20.7	13.8	20.7	17.0	0	6.9
Competences of industrial-technological (service-operational) activities	0	0	0	24.3	10.3	13.8	13.8	31.0	3.4	3.4

Source: compilation according to the results of the survey.

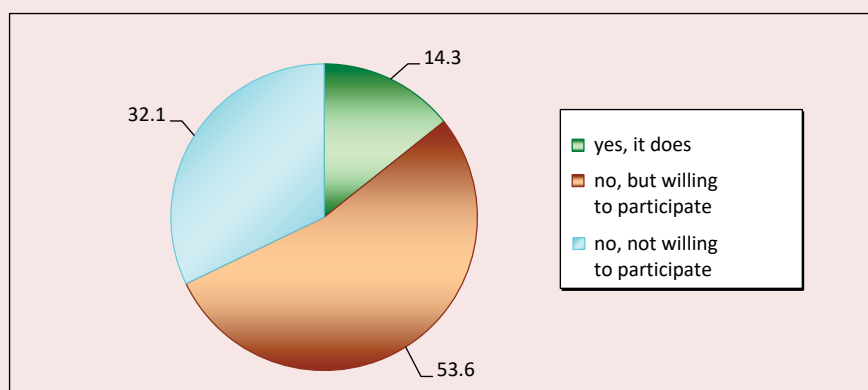
points. The highest score was given by respondents to the level of development of competencies of production and technological (service and maintenance) activities. Almost one third of the respondents (31%) gave the development level of this group of professional competencies 8 points (Tab. 7).

The level of development of analytical, organizational and managerial competencies among the graduates of the Vologda Oblast universities is below average. The focus on the development of these groups of professional competencies in the educational programs of the region's universities, related to IT training, is expressed to a lesser extent, which indicates the regularity and interconnectedness of these trends.

Another contradiction is that, despite the importance of analytical thinking as one of the main competences for IT specialists²⁴, this very group of professional competences is practically not formed by the students of universities in the Vologda Oblast.

An important tool to address the above problems is the organization of dual education system – the interaction of universities with IT companies as a way to overcome the mismatch between the field of education and the labor market [25]. Most of the respondents (53.6%) indicated that this model is not implemented in their organizations, but expressed their willingness to cooperate with universities in the Vologda Oblast. About 14.3% of the heads of IT companies noted that they participate in the dual education system (Fig. 2).

Figure 2. Distribution of answers to the question "Does your organization participate in the dual education model with the universities of the Vologda Oblast?", % of respondents



Source: own compilation according to the survey results.

²⁴ Atlas of Emerging Jobs. Available at: https://www.skolkovo.ru/public/media/documents/research/sedec/SKOLKOVO_SEDeC_Atlas.pdf

One of the factors restraining the interaction between universities and companies is the financial factor. Employers state that organizations have no financial opportunities for cooperation and it is very costly and burdensome to participate in such cooperation unilaterally²⁵. The mobility of personnel, the possibility of changing their specialization and place of work, as well as the inability of companies to provide employees with full employment or decent career growth do not stimulate investment in personnel development. In this case it is inexpedient for companies to invest in training a person who is “difficult to retain”²⁶.

The non-participation of companies in dual education projects partially explains the fact that in half of the cases employers note the absence of graduates participating in the dual education project in the company staff. However, almost every third IT company managers who have such employees say

that the quality of professional training of graduates is significantly different for the better, hence they have the potential to be developed (Fig. 3).

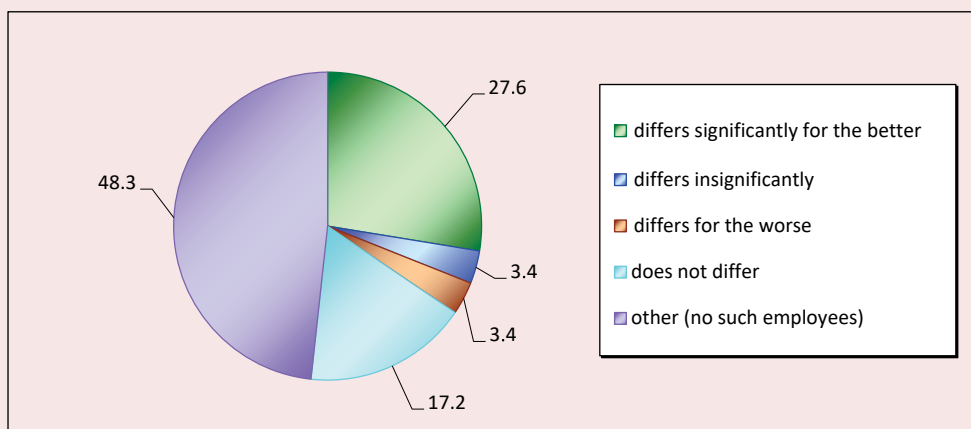
Thus, the results of the survey of IT managers confirmed the conclusions that the knowledge and skills of Vologda Oblast university graduates do not meet the requirements of employers, which subsequently leads to the lack of demand for IT specialists in the labor market. The problem of staffing will be exacerbated in the conditions of a reduction in the number of graduates in IT directions.

Problems and solutions

The analysis allowed distinguishing a number of problems, which characterize the ineffectiveness of the education system and require a solution.

Problem 1: The mismatch between the current list of specialties in higher education institutions and the challenges of the digital economy and the processes of informatization.

Figure 3. Distribution of answers to the question “If your organization employs an IT graduate who is a participant of the dual education project, is the quality of his/her professional training different compared to the graduates who did not participate in the dual education system?”, % of respondents



Source: own compilation according the survey results.

²⁵ Employers and educational institutions: how to achieve interaction? Available at: <https://vologda.hh.ru/article/22034>; Zarubin V.G., Savin I.V., Tumalev V.V. What prevents the employer from interacting with the university: the experience of the study of stereotypes. Available at: <http://www.ibl.ru/konf/041208/67.html>

²⁶ The master stays out of the picture. Available at: <https://rg.ru/2020/09/30/v-rossii-nabiraet-populiarnost-dualnaia-forma-obucheniia-studentov.html>

It would be advisable to initiate the adjustment of the list of training areas for IT specialties in accordance with the needs of employers. And it is possible to do this at the level of the Ministry of Science and Higher Education of the Russian Federation. Key areas could be those related to data analysis, machine learning, Big Data, virtual and augmented reality technologies, cybersecurity, robotics, quantum computing, blockchain, etc. The training process must be flexible and be able to be adjusted immediately when the need arises, without postponing the process, otherwise the mismatch between the level of training and the requirements imposed by new technological challenges will persist.

Problem 2: The low share of IT training in the total volume of all specialties

In order to solve the problem, it is necessary to expand the range of areas of training in the direction of IT specialties due to the emergence of new areas of training relevant to the digital economy. A number of areas not directly related to IT (mathematics and mechanics, physics, engineering, etc.) can be adapted to the requirements of digitalization and informatization processes through the use of digital and information technology in the learning process to develop digital literacy in future professionals.

Problem 3. There is a general decreasing trend in the number of graduates of universities in IT-related fields

It is necessary to increase the admission quotas, primarily in the areas of training related to computer science, information science, information security, etc., as well as in promising areas. The growth of admission quotas requires an increase in the number of applicants. It is important that educational organizations form demand by conducting career guidance work already at the stage of school education. For this purpose, one can organize specialized classes with in-depth study of IT, holding open days in IT organizations, lectures by teachers

and professors of leading universities in the region for schoolchildren on the possibilities of applying knowledge in the field of IT, etc. In addition, the experience of the Vologda Oblast showed that there is a certain mismatch between the regulatory framework at the regional and federal levels; in the passport of the federal project "Personnel for the Digital Economy", which is implemented as part of the national program "Digital Economy of the Russian Federation", the indicator "the number of admissions to higher education programs in IT and mathematical specialties", and its annual target values is designated; in a similar passport of the regional level (Vologda Oblast) this parameter is missing. Consequently, it is necessary to eliminate the discrepancies in the legislative documents of different levels.

Problem 4: Uneven distribution of groups of professional competencies, the formation and development of which is the focus of the educational. Mismatch between the current list of professional competencies developed in students and the challenges of the digital economy

The solution to the problem can be associated with the development of methodological recommendations, which would adjust the hours of disciplines to ensure equal development of different groups of professional competencies in students. This will allow preparing IT specialist comprehensively and form all the necessary competencies. Considering the requirements of employers, first of all, it is necessary to increase the proportion of hours for the development of analytical and project activity competences, since the focus on the formation of analytical and organizational and managerial competences is missing in a number of educational programs. This is partly due to the fact that every third respondent characterized the level of development of project activity competencies among graduates at 4 points on a ten-point scale.

It is necessary to consider adjusting the list of professional competencies, as stated in the FSES (Federal State Educational Standards), to include such competencies as critical thinking, analytical thinking, creativity, cognitive flexibility, adaptability. In addition, it would be appropriate to specify each group of professional competencies in more detail for each IT direction and training profile with an indication of the abilities formed within their framework.

Problem 5: Low level of practice-oriented educational programs in IT training areas

It is possible to address this issue by a more even distribution of academic hours of courses so that the proportion of practical training is not less than 16.7% of academic hours (in accordance with the structure developed in the article). To reduce the problem of mismatch between the skills obtained by graduates in universities and the requirements of the labor market, it is important to involve representatives of IT business in the organization and conduct of student internships. Such cooperation will allow training specialists whose knowledge, skills and abilities will be really in demand in the labor market.

Problem 6: Breakdown in continuity between educational programs at different levels

It is advisable to change the approach to graduate admission to a master's degree program by retaining the educational program after graduation from the bachelor's degree, which will help avoid breakdown in continuity while forming competencies at different levels.

Problem 7: The low level of interaction between universities and the real economy

It is important to explore the possibility of implementing the mechanism of dual education system at the state level. One should note that the Strategy for socio-economic development of the Vologda Oblast for the period through to 2030

emphasizes the need for cooperation between educational institutions of higher education and the real sector of the economy. However, such cooperation is limited only by the creation and development of an information platform²⁷. Thus, as of today, the possibility to implement the dual education system is not enshrined in the normative framework.

It is advisable to develop measures at the federal level to stimulate universities and companies for cooperation. This is possible through creation of legal conditions for companies to invest in equipment and infrastructure, and for universities to provide facilities and maintain them in good working order, and to introduce evaluation mechanisms for educational services. It seems important to reduce information asymmetry, which implies, among other things, building a system for assessing labor market needs (conducting regular surveys) and creating an information system linking entities of educational and professional spheres.

The implementation of dual education system can help to find solutions to a number of problems outlined above. The interaction of universities with IT companies will allow forming a relevant and demanded list of IT specialties in educational institutions, adjusting the list of necessary professional competencies, educational programs, so that their content and requirements for the results of their study correlated with the requirements of employers, etc.

In addition, it is advisable to implement the mechanism of employer-sponsored education through the conclusion of a contract between a student with the participation of the educational organization, where the training is planned, and

²⁷ "On the Strategy for socio-economic development of the Vologda Oblast for the period through to 2030": Vologda Oblast Government Decree no. 920, dated October 17, 2016. Available at: <https://vologda-oblast.ru/upload/iblock/cfe/strategiya2030.pdf>

the enterprise-employer, which guarantees a place of work. In 2020, the Governor of the Vologda Oblast announced the allocation of 200 places for employer-sponsored education at the expense of the regional budget in the in-demand areas of training, including computer science and computer technology. However, one should note that the applicant for employer-sponsored education must choose pedagogical specialties, hence the opportunities to participate in this model of training are limited²⁸. In this regard, it seems appropriate to expand the list of directions of IT training, relating not only to pedagogical specialties.

The implementation of employer-sponsored education can also contribute to “bringing” training in universities in line with the changing demands of society, the formation of a system of “bringing” a specialist to the workplace.

Conclusion

Thus, with the ever-growing digitalization of the economy, the human resources of the IT industry can become the main source of growth of the national economy as a whole. The rapid development of digital and information technologies leads to an increase in the demand for IT specialists, and also apply new competence requirements. One of the main sources of reproduction of human

resources is educational organizations. The analysis showed that the main problem of training specialists for the IT industry is the mismatch between the education system and the labor market. With the growing demand for IT specialists, the personnel shortage will only increase. The proposed measures to solve the problems highlighted in the study of reproduction of IT staff will provide continuity and consistency in the training of specialists.

The materials of the study can be used by researchers, post-graduate and undergraduate students dealing with the problems of digital economy development, and issues related to the staffing of this industry. The presented research is of a comprehensive nature, its results contribute to the expansion of theoretical aspects of the study of the IT training problems. The practical significance of the work lies in the fact that the developed proposals for addressing the identified issues can be used by federal and regional authorities and management in adjusting the plans for implementing the national projects “Digital Economy” and “Education”, and should also be reflected in the objectives of other legal documents in education at the federal and regional levels. Along with this, the material can be used for scientific substantiation of measures aimed at optimizing the training system of IT specialists.

References

1. Freeman C., Soete L. *The Economics of Industrial Innovation: A Study of Long Waves and Economic Development*. Pinter: London, 1997.
2. Schwab K. *The Fourth Industrial Revolution*. Penguin, 2017.
3. Bell D. *The Coming of Post-Industrial Society: A Venture in Social Forecasting*. New York: Basic Books, 1999.
4. Safronova A.A. Modern trends of development of information technologies industry. *Transportnoe delo Rossii=Transport Business in Russia*, 2013, no. 4, pp. 94–95 (in Russian).
5. Schumpeter J.A. The theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle. *Harvard Economic Studies*, 1934, no. 46.

²⁸ Another 200 places for employer-sponsored education for applicants were allocated in the Vologda Oblast. Available at: https://vologda-oblast.ru/novosti/novosti_organov_vlasti/eshchye_200_mest_na_tselevoe_obuchenie_dlya_abiturientov_vydeleno_v_vologodskoy_oblasti

6. Mazilov E.A., Davydova A.A. Scientific and technological development of Russia: State assessment and financing problems. *Ekonomicheskie i sotsial'nye peremeny: fakty, tendentsii, prognoz*=*Economic and Social Changes: Facts, Trends, Forecast*, 2020, vol. 13, no. 5, pp. 55–73 (in Russian).
7. Gainanov D.A., Kliment'eva A.Yu. The priorities of staffing the digital economy. *Kreativnaya ekonomika*=*Journal of Creative Economy*, 2018, no. 12, pp. 1963–1976 (in Russian).
8. Vasil'eva E.V. Reproduction of staff of IT-branch. Scenario analysis. *Mir novoi ekonomiki*=*The World of New Economy*, 2016, no. 4, pp. 127–134 (in Russian).
9. Zinenko G.V. Staff training in the field of information technology. *Molodoi uchenyi*=*Young Scientist*, 2017, no. 11(145), pp. 206–208 (in Russian).
10. Agapov I. Personnel of the digital economy. *Standart*=*Standard*, 2019, no. 7–8(198–199), pp. 12–15 (in Russian).
11. Bartlett W. The effectiveness of vocational education in promoting equity and occupational mobility amongst young people. *Economic Annals*, 2009, no. 54 (180), pp. 7–39.
12. Klimova Yu.O. Analysis of staffing in the information technology industry at the federal and regional levels. *Vestn. Omsk. un-ta*=*Herald of Omsk University*, 2020, no. 1, pp. 126–139 (in Russian).
13. Shpil'berg S.A. Staffing of the innovative economy. *Vestn. Sibir. gos. aerokosm. un-ta im. akad. M.F. Reshetneva*=*Bulletin of the Siberian State Aerospace University*, 2006, no. 2(9), pp. 145–149 (in Russian).
14. Antoshina N.M. Formation of the personnel of the state civil service. *Vlast'*=*The Authority*, 2009, no. 5, pp. 8–10 (in Russian).
15. Binert O.V. Staffing – the basis of the activities of any enterprise. *Upravlenie sovremennoi organizatsiei: opyt, problemy i perspektivy*=*Management of a Modern Organization: Experience, Problems and Prospects*, 2016, no. 1, pp. 397–401 (in Russian).
16. Anisimova N.Yu. Organizational and economic mechanism of quality management of staffing of agro-industrial complex of the region. *Vestn. Evraz. Nauk*=*The Eurasian Scientific Journal*, 2018, no. 6, pp. 1–11 (in Russian).
17. Barchan N.N., Kotov A.A., Chumachenko A.P. Management staffing: The decomposition of goals. *Vestn. nauchn. konf*=*Bulletin of Scientific Conferences*, 2017, no. 3–4(19), pp. 9–11 (in Russian).
18. Nordin M., Persson I., Rooth D.-O. Education-occupation mismatch: Is there an income penalty? *IZA Discussion Paper*, 2008, no. 3806.
19. Robst J. Education, college major and job match: Gender differences in reasons for mismatch. *Education Economics*, 2007, no. 15.
20. Ustinova K.A., Popov A.V. Inclusion of young people in the work: mental barriers and ways to overcome them. *Monitoring obshchestvennogo mneniya: ekonomicheskie i sotsial'nye peremeny*=*Monitoring of Public Opinion: Economic and Social Changes*, 2018, no. 6, pp. 333–346 (in Russian).
21. Heckman J.J., Jacobs B. Policies to create and destroy human capital in Europe. *IZA Discussion Paper*, 2009, no. 4680.
22. Klyucharev G.A., Latov Yu.V. Additional supplementary education and vocational training of graduates and young employees as a bridge between education system and labor market. *Obshchestvennye nauki i sovremennost'*=*Social Sciences and Contemporary World*, 2016, no. 1, pp. 20–33 (in Russian).
23. Klimova Yu.O., Uskov V.S. Problems of competencies formation among IT-specialists in the Vologda Oblast universities. *Voprosy territorial'nogo razvitiya*=*Territorial Development Issues*, 2020, no. 5, pp. 1–15 (in Russian).
24. Senashko V.S., Pykhtina N.A. Continuity of undergraduate and graduate programs as a key factor of the quality assurance in higher education. *Vyssee obrazovanie v Rossii*=*Higher Education in Russia*, 2017, no. 12(218), pp. 13–25 (in Russian).
25. Dudyrev F.F., Romanova O.A., Shabalin A.I. Dual education in regions of Russia: Models, best practices, growth prospects. *Voprosy obrazovaniya*=*Educational Studies Moscow*, 2018, no. 2, pp. 117–138 (in Russian).

Information about the Authors

Yulia O. Klimova – Junior Researcher, Vologda Research Center, Russian Academy of Sciences (56A, Gorky Street, Vologda, 160014, Russian Federation; e-mail: j.uschakowa2017@yandex.ru)

Kseniya A. Ustinova – Candidate of Sciences (Economics), Senior Researcher, Vologda Research Center, Russian Academy of Sciences (56A, Gorky Street, Vologda, 160014, Russian Federation; e-mail: ustinova-kseniya@yandex.ru)

Received March 23, 2021.