

**WILLINGNESS OF RUSSIAN RESEARCHERS TO DIGITAL  
TRANSFORMATION: BASIC DIGITAL LITERACY  
AND ADVANCED SKILLS**

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**Abstract.** The development of information technologies and rapid growth in the volume of accumulated data makes it necessary to develop new scientific approaches, technologies and methods for collecting, processing and storing information. Digitalization has significantly affected people employed in science and technology: the ability to work with large amounts of information, the knowledge of statistics, and the ability to correctly publish research results became crucially important. For researchers the possession of digital skills signifies the confident use of new data analysis tools and implementation of new technologies.

Research practices and competencies of Russian doctorate holders are examined within the framework of the project “Monitoring survey of Highly Qualified R&D Personnel” (National Research University Higher School of Economics, 2010-2019). One of the objectives of the project was to assess the readiness of Russian researchers for digital transformation and to found out to what extent modern digital technologies have taken over the activities of Russian Doctorate holders. It was analyzed whether Russian scientists are familiar with modern digital terminology, whether they apply modern data processing tools in practice and whether they are ready to improve own digital skills.

The sample included the total of 2061 Russian Doctorate holders, representing all fields of science, and employed in the academic sector (research institutes and universities), as well as in industrial and service sector companies.

The professional activity of most Russian Doctorate holders is associated with the regular use of information technologies. Among the surveyed PhD holders, 85% reported that they regularly use computers and the Internet, another 10% use them periodically. But scientific work involves not only basic computer skills, but also advanced data analysis tools. Our results show that less than half of Russian Doctorate holders are aware of modern digital technologies, except for Big Data Analysis. Moreover, a number of

digital tools and technologies are well-known, but have not yet found widespread practical application.

The “digital outlook” can come from the general erudition of the Doctorate holder or from the practical experience of using various digital tools: researchers can be clearly divided into “abstractly informed” and “practitioners”. Employees of research institutes, who are more aware of the meaning of digital terminology, use new digital technologies much less frequently than their colleagues from universities and the non-academic sector. A similar situation is observed when comparing age groups: while the youngest scientists are more often aware of the meaning of digital terms, middle-aged and older scientists, if they know the digital technologies, also quite often use them in practice.

Every third Doctorate holder in Russia at least occasionally uses Big Data analysis, every fourth – Data Mining, User interface design, Cloud and distributed computing, every fifth – Text Mining, Machine Learning, Applied Mathematical Optimization.

The use of particular digital technologies varies according to the type of organization: User Interface Design is more often practiced outside the academic sector, while Big Data Analysis and Machine Learning are more actively used by Doctorate holders employed in research institutes and universities. The biggest number of employees who deal with Mobile Application Development appeared in the research Institutes.

The most advanced digital users are those who specialized in natural sciences, engineering sciences, social sciences, and mathematics; PhD holders in agriculture are the least informed.

A significant part of Russian scientists already have experience in improving their digital skills by taking part in various computer courses. Over the last 3 years, every fifth Doctorate holder (18.9%) attended computer courses. However, emphasizing digital skills, it is important not to forget about the importance of soft and hard skills, that employers expect from researchers.

**Keywords:** Digital skills, digital literacy, researchers, doctorate holders, lifelong learning

### **Introduction**

The development of information technologies and rapid growth in the volume of accumulated data makes it necessary to develop new scientific approaches, technologies and methods for collecting, processing and storing information. Significant scientific results can be obtained on the basis of the intellectual analysis of huge arrays of accumulated data in various subject areas. In addition to the increasing availability of data, digitalization affects

the process of knowledge creation itself. It expands access to scientific knowledge and opens up new channels for fast and intensive research cooperation. The intensity of international scientific cooperation is increasing due to new communication channels of and scientific platforms based on advanced technologies. Digitalization has affected people employed in science and technology: the ability to work with large amounts of information, the knowledge of statistics, and the ability to correctly publish research results became crucially important (Vitae, 2010; De Grande *et al*, 2011).

Digital skills are one of the most demanded competences for many professions, at least at the level of ability to work with electronic documents, to create presentations and to find the necessary information. However, the researcher activity is usually associated with performing more complex tasks that require knowledge of advanced methods and specialized programs. There is a difference between digital literacy, understood as basic technical use of computers and the Internet, and professional ICT skills, that are part of hard skills for “workers who drive innovation and to support digital infrastructures and the functioning of the digital eco-system” (The European Parliament, 2006; OECD, 2016).

For researchers the possession of digital skills signifies the confident use of new data analysis tools and implementation of new technologies. The most searched skills are related to big data, Internet of things and artificial intelligence (Meissner *et al*, 2016). Scientists have to develop advanced digital skills related to information processing, modern methods of research, publishing standards for data and results.

### **Purpose of the study**

Research practices and competencies of Russian doctorate holders were examined within the framework of the project “Monitoring survey of Highly Qualified R&D Personnel”. In 2017, one of the goals of the project was to assess the willingness of Russian researchers for digital transformation and to found out to what extent modern digital technologies have taken over the activities of Russian Doctorate holders. It was analyzed whether Russian scientists are familiar with modern digital terminology, whether they apply modern data processing tools in practice and whether they are ready to improve their own digital skills.

### **Methodology**

The sample included the total of 2061 Russian Doctorate holders (53,6% of them male). The respondents comprised researchers employed at R&D divisions of universities, research institutes, engineering services providers, industrial companies, medical centres, and clinics. 89,6% were employed at the academic sector (out of them, 31,7% worked at research institutes and

57,9% – at universities); 10,4% were primarily employed by industrial and service sector companies.

The survey was conducted in all Russian federal districts in large cities with research institutes and major universities, and in “naukograd” (science cities). Data about Russian doctorate holders was collected through a sampled survey using a multistage stratified sample, with respondent quotas established for age groups, gender, specialization areas, employment sectors, and territories of residence (federal districts). All the data are self-reported.

## **Results**

### *1. Basic digital skills*

The professional activity of most Russian Doctorate holders is associated with the regular use of information technologies. Among the surveyed PhD holders, 85% reported that they regularly use computers and the Internet, another 10% use them periodically. The cases when doctorates hardly ever work with a computer are isolated (they are usually senior and middle aged employees; most of them are employed by universities). 48% of respondents regularly collect and process data using information technology, and 33% – occasionally.

### *2. Professional digital skills*

#### *2.1. Awareness of digital terminology*

The scientific work is associated not only with basic computer skills, but also involves the appliance of advanced data analysis tools. The newest digital technologies and terms, that were unfamiliar to most people 10 years ago, are now becoming widely known. Figure 1 shows how well Russian Doctorate holders are aware of the current digital terminology (share of respondents who indicated that they are familiar with the term). The data are presented both on average for the sample and by types of organizations.

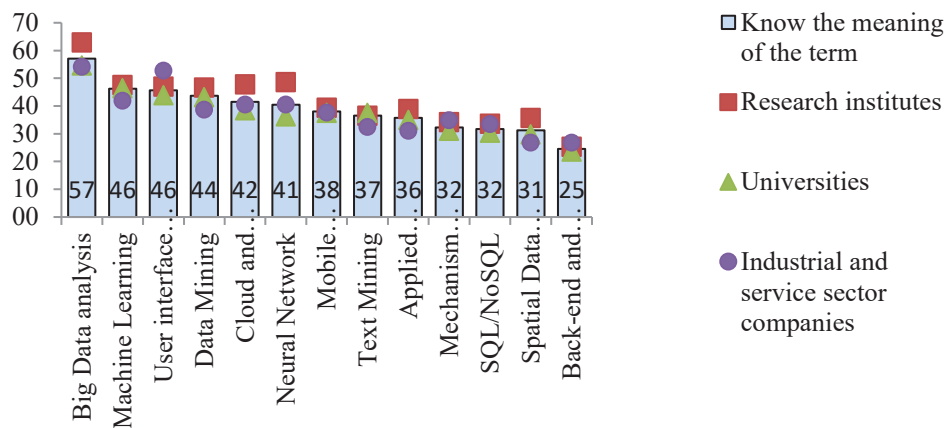


Figure 1 – Level of awareness of Russian Doctorate holders, %

The only term that is familiar to more than half of respondents (57,1%) is Big Data Analysis. Including it, the top 5 digital terms are Machine Learning, User Interface Design, Data Mining, Cloud and Distributed Computing.

The employees of research institutes are the most aware of modern IT-technologies (for most terms, the awareness in research institutes is higher than in universities and non-academic organizations).

Young scientists are also more familiar with the digital terminology: the difference in the level of knowledge between the group aged under 29 and the average level across the sample for certain technologies reaches 10–15%. For example, 67% of young scientists are aware of the term Big Data analysis (compared with 57.1% on average). With the term Data Mining are familiar 60% of young scientists compared with 43.7% on average for the whole sample.

The most advanced digital users are those who specialized in natural sciences, engineering sciences, social sciences, and mathematics; PhD holders in agriculture are the least informed.

There are no significant differences in the digital horizon scope between professionals and managers on the terms above.

The difference between those who are actively involved in research and development, and those whose responsibilities do not include research functions is much greater: for example, the term Big Data Analysis is familiar to 59% of researchers and while only to 43% of non-researchers.

## 2.2. Use of advanced digital skills in practice

Every third Doctorate holder in Russia at least occasionally uses Big Data analysis, every fourth – Data Mining, User interface design, Cloud and distributed computing, every fifth – Text Mining, Machine Learning,

Applied Mathematical Optimization. Figure 2 shows data on the use of certain digital technologies (among those who know the listed terms).

Big Data analysis	30	27	43
Machine Learning	21	25	54
User interface design	24	22	54
Data Mining	26	18	56
Cloud and distributed...	23	18	59
Neural Network	14	26	60
Mobile application...	15	23	62
Text Mining	21	16	63
Applied Mathematical...	20	16	64
Mechanism Design	13	20	68
SQL/NoSQL	14	18	68
Spatial Data Analysis	17	14	69
Back-end and Front...	10	14	76

- Know the term and use the technology
- Know the term, but do not use the technology
- Do not know the term

Figure 2 – Use of digital technologies by Russian Doctorate holders, %

Knowing about a certain digital technology is not the same thing as using it in practice. The technology may be well-known and promising, but not yet found a wide practical application. About 40% of researchers know about neural networks, but most of them do not use them in their work. The popularity of this technology lags far behind the scale of its actual use in the professional activities of Russian Doctorate holders. At the same time, there are a number of technologies that are not so well-known, but if researchers are aware of them, it is usually because they really use them: first of all, Data Mining, Text Mining, Applied Mathematical Optimization, Spatial Data Analysis.

The use of particular digital technologies varies according to the type of organization: User Interface Design is more often practiced outside the academic sector, while Big Data Analysis and Machine Learning are more actively used by Doctorate holders employed in research institutes and universities (Figure 3). The biggest number of employees who deal with Mobile Application Development appeared in the research Institutes.

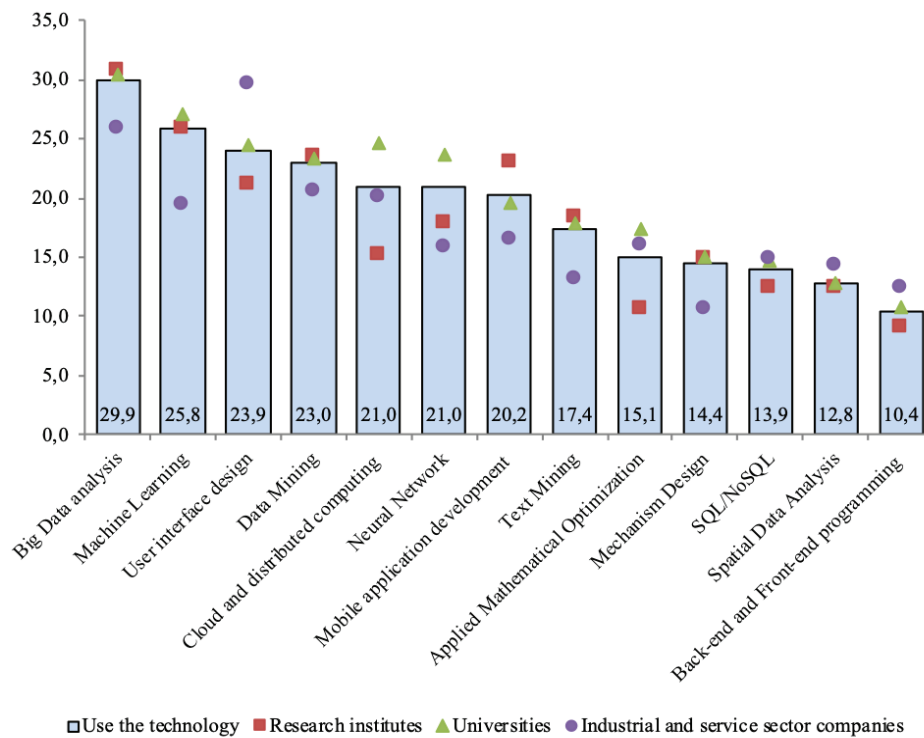


Figure 3 – Use of technology by type of organization, %

New digital technologies are often highly specialized and may be practically used only in some research areas. In various fields of science and technology, modern information tools are used unevenly (Table 1). Representatives of technical sciences are leaders in appliance of modern digital technologies. The Big Data and Data Mining technologies are also actively used by researchers who work in the field of natural sciences and mathematics. At the same time, representatives of the social sciences and humanities are using Text Mining and Machine Learning almost as often as researchers engaged in the natural sciences and mathematics.

**Table 1 - Use of digital technologies by field of science, %**

	Natural sciences and mathematics	Engineering sciences	Medical and health sciences	Agricultural science	Social science	Humanities
Big Data analysis	32,5	33,9	30,8	22,1	31,4	23,4
Data Mining	29,2	32,3	23,5	16,8	23,1	18,8
Text Mining	19,6	26,0	18,7	18,9	20,7	19,3
Machine Learning	19,7	29,3	14,8	9,3	19,8	20,9
Spatial Data Analysis	20,9	19,3	14,1	13,3	17,1	13,1
Applied Mathematical Optimization	24,2	34,8	9,8	9,7	13,6	8,8
Mechanism Design	10,9	26,9	9,0	5,8	7,0	6,6
Cloud and distributed computing	27,8	29,7	13,3	8,9	24,3	16,4
Back-end and Front-end programming	10,9	18,0	4,8	5,4	9,3	4,7
Neural Network	14,9	22,0	10,0	9,3	16,7	7,9
SQL/NoSQL	15,8	22,7	6,9	6,1	15,1	5,0
Mobile application development	11,6	22,9	10,5	8,0	19,4	13,5
User interface design	24,0	32,0	22,4	7,8	23,8	20,6

### *3. Improvement of digital skills*

The significant share of researchers is now realized that their level of digital skills must be constantly improved in order to keep pace with the modern scientific and technological development and participate in international scientific cooperation. Various computer courses (including courses in specialized software) are one of the most common forms of additional education among Russian researchers. Over the last 3 years, every fifth Doctorate holder (18.9%) attended computer courses. They are most actively attended by older scientists (50-70 years old), who are willing to adapt to the digitalization through improving digital skills.



## **Discussion**

The majority of Russian Doctorate holders are regularly use basic digital skills in their professional activity and at least occasionally apply advanced methods of data collection and processing by using information technology. However, less than half of Russian Doctorate holders are aware of modern digital technologies, except for Big Data Analysis. Moreover, a number of digital tools and technologies are well-known, but have not yet found widespread practical application.

The “digital outlook” can come from the general erudition of the Doctorate holder or from the practical experience of using various digital tools: researchers can be clearly divided into “abstractly informed” and “practitioners”. Employees of research institutes, who are more aware of the meaning of digital terminology, use new digital technologies much less frequently than their colleagues from universities and the non-academic sector. A similar situation is observed when comparing age groups: while the youngest scientists are more often aware of the meaning of digital terms, middle-aged and older scientists, if they know the digital technologies, also quite often use them in practice.

A significant part of Russian scientists already have experience in improving their digital skills by taking part in various computer courses. However, emphasizing digital skills, it is important not to forget about the importance of soft and hard skills, because in addition to technical skills, employers expect from researchers leadership skills, communication skills, creative approach and knowledge of business processes.

**Acknowledgements.** The research project “Monitoring survey of Highly Qualified R&D Personnel” is realized in the framework of Basic Research Program Higher School of Economics (NRU HSE) in 2010-2019. This paper was prepared within the framework of the Basic Research Program at the National Research University Higher School of Economics (HSE) and supported within the framework of a subsidy by the Russian Academic Excellence Project '5-100'.

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