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LEVEL OF DIGITAL SKILLS OF THE EMPLOYED: KEY DETERMINANTS

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LEVEL OF DIGITAL SKILLS OF THE EMPLOYED: KEY DETERMINANTS

The impact of digitalization on the labor market is widely discussed by economists. In the study, we analyze the impact of socio-economic and professional characteristics on the development of digital skills of an individual. In the analysis several indicators of ICT skills are used: number of skills by their complexity, specific areas of application and total number of ICT skills. The study is based on the combined data of two sample surveys conducted by Rosstat: Federal Statistical Observation on the Use of Information Technologies and Information and Telecommunication Networks by the Population and Russian Labor Force Survey. The study also provides comparison of digital skills in Russia and with the EU countries. Based on the OLS results, it was revealed that socio-demographic characteristics greatly influence on the development of less complex digital skills which are necessary in everyday life, while the professional characteristics of the employed determine possession of complex digital skills that require special training or education. ICT infrastructure has a great impact at the all types of digital skills.

Key words: digitalization, digital skills, human capital

Jel code: J24

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Introduction

The impact of digitalization on the labor market is widely discussed [Acemoglu and Restrepo, 2020], [Pirosçă et al, 2021]. Firstly, the demand for digital (information and communications technology (ICT)) skills grows in various occupations. Advanced computer and Internet skills are required not only for ICT specialists, but also for physicists, doctors, teachers, operators and other workers. Secondly, digital technologies lead to the transformation of labor functions in many workplaces. Thirdly, jobs that involve largely routine activities are being replaced by technologies, at the same time new occupations emerge in the sphere of creation and operation of digital content [Fossen and Sorgner, 2019].

A large number of countries agreed to increase the proportion of youth and adults with ICT skills within the framework of the sustainable development goals adopted by the UN in 2015. according to the European Skills Agenda, 70% of adults aged 16-74 should have at least basic digital skills by 2025 [European Commission, 2022].

Measures aimed to increase digital literacy of the population are also being implemented in Russia. Firstly, financing of higher education in the areas of information technology and mathematics is increased. Secondly, professional training in “digital professions” is co-financed by the state. Thirdly, "digital departments" are being opened in universities to develop digital skills of the students. Finally, special professional training of public sector employees and teachers in organizations of secondary vocational education is carried out [National project ‘Digital economy’, 2022]. Despite this, in Russia there is still a shortage of ICT specialists and digital skills of population [RIA, 2022].

Previous research [NRU HSE, 2021] show that the level of digital skills of the Russian population varies significantly across socio-demographic groups. Young people aged 16-24 have a higher level of digital skills than middle-aged people (from 25 to 54 years old) and older (55 years old and over): 97.6% of young people have digital skills, 93.2% among middle-aged people. aged and 50.9% among the elderly. Furthermore, variance exists by type of place of residence: 81,1% of urban population and 70,2% those living in a countryside have digital skills. ICT skills level also depend on the labor force status: 89% of the employed and 81% of the unemployed have digital skills, while among those outside the labor force only 60% have digital skills. There is also variation in the level of digital skills across occupations. Only 1% of ICT specialists do not have digital skills although the share of those employed in other groups without digital skills is 19%.

Thus, digital skills of Russian population vary by socio-demographic and professional characteristics, but the influence of each factor has not been assessed yet. At the same time, in order to introduce effective policies for the development of the digital economy, it is necessary to understand the contribution of various characteristics to the level of digital skills. Our research aims to fill this gap. The article's goal is to estimate the influence of various socio-demographic and professional features of the employed population on individuals' digital skills.

Literature review: Key determinants of digital skills

Digital skills are a form of human capital. Its growth promotes an increase in labor productivity which leads to the raise of salary [Schultz, 1961] and [Becker, 1964]. Becker [1964] highlighted two types of investments in human capital: development of special and general knowledge and abilities. Special competencies are applied at the specific workplace, general skills can be use in all workplaces. Thus, basic digital skills (working with text editors, tables, writing emails, etc.) refer to general human capital and advanced skills - to special. According to the theory, there are different forms of investment in the human capital: education and training, professional experience and others.

Empirical studies confirm that the level of education is one of the key determinants of digital skills level [van Laar et al, 2019], [Heinz, 2016]. The International Telecommunication Union (ITU) reports that not only education, but also all other types of training and learning play a crucial role in the development of ICT skills [ITU, 2020a]. It is noted that the gap in the level of digital skills between men and women in some countries exists due to the inaccessibility of education to girls [ITU, 2020a].

There are also several other groups of factors that tend to determine the individuals' skill level.

Development of digital technologies play a crucial role. They lead to the emergence of new ways of working with information which encourages the continuous renewal of digital skills [Tolstykh et al, 2018]. For example, any changes in the applications lead to changes in users' skills.

Nowadays 93% of the population live in the areas covered by at least a 3G mobile signal of the Internet, but quality and cost of the Internet connection still vary [ITU 2020b]. It was revealed that the last two factors and price of the gadgets are the main reasons for limiting the use of the Internet [ITU 2020b]. People who do not use the Internet, do not have any digital skills. Open access to ICT at school and at home is one of the most important determinants of the digital skills gap

between school children [De Haan J, 2010]. van Laar (2019) revealed that the following personal characteristics positively influence the development of digital skills of employed:

- attitude to ICT;
- perceived ease of use;
- self-regulation in the sphere of ICT (the tendency to remain patient and make efforts to achieve goals, despite potential distractions of the Internet);
- independent learning; personal initiative;
- formal and informal social support.

The level of a person's digital skills depends on the place of residence. The results of the study by Lizzie Richardson and David Bisbal [2019] indicate that the type of residence and the quality of digital infrastructure affect the level of an individual's digital skills. The better the infrastructure (affordability and quality of the Internet connection, the affordability of devices for using the Internet and other) of the place of residence, the higher the digital skills level. The authors note that digital skills level differs across the country's cities. There is a concentration of technologies and highly qualified workers in one center of the country, which ensures the rapid development of digital technologies, other regions cannot provide the population with the necessary conditions for digital skills development.

The early use of the Internet by children has a positive influence on the level of their digital skills [Hurwitz and Schmitt, 2020]. It is easier for children to master new abilities if they got early access to the Internet. But there is also a negative effect, due to the fact that some children may have a problem with their school performance despite the high level of digital skills. On the opposite, usage of the Internet is not enough for formation of high level of digital skills [Heinz, 2016]. Children must use the Internet conscious and the Internet should be included in education process both in specialized and in the rest of the lessons.

Eventually it shows that digital skills are a complex concept. A group of factors influence its development: ICT infrastructure (not only the fact of having a network, but also its quality, stability and accessibility), level of education, attitude of a person and the persons experience of interaction with ICT, type of place of residence. The article focuses on the influence of the characteristics of the

employed and their workplace on the digital skills level in Russia. We also take into consideration ICT infrastructure in the household.

Methodology

The study is based on the combined data of two sample surveys conducted by Federal State Statistics Service: 1) Federal Statistical Observation on the use of Information Technologies and Information and Telecommunication Networks by the Population and 2) Russian Labor Force Survey. The sources contain detailed information about labor activity and the use of ICT by the population. The analysis used data for 2021. The sample size is 70 thousand employed people, which corresponds to 0.12% of the employed population of Russia, aged 15 years and older. Survey data are representative at the country level.

The study draws upon standard definitions of digital skills. First, the article considers the ILO Guidelines concerning measurement of qualifications and skills mismatches of persons in employment adopted by 20th International Conference of Labour Statisticians [ILO, 2018], skills are defined as «the innate or learned ability to apply knowledge acquired through experience, study, practice or instruction and to perform the tasks and duties required by a given job». There are 3 types of skills: *basic* (such as literacy, numeracy and basic ICT skills), *transferable* (such as soft skills, language skills), *job-specific/technical* (knowledge and abilities to perform certain professional tasks). Various digital skills can be attributed to different types of skills according to ILO classification. Such skills as using text editor or browser are basic skills, working with special software - job-specific skill. Second, the definition by the International Telecommunication Union (ITU)[3] which postulates digital skills as «knowledge and skills necessary for a person to be able to use ICT to achieve goals in his personal and professional life» is taken into account. Digital skills are constantly changing, because of technical development and appearance of new forms of work. Moreover, digital skills include not only actions using ICT, but a combination of behaviors, experience, "knowledge, work habits, character traits, predisposition and ability to think critically" [ITU, 2020b].

ITU has introduced classification of the digital skills dividing skills by complexity:

- *Basic skills* - provide a framework for the use of ICT (use of devices, performing basic online operations).

[3] A specialized organization of the UN system, which includes 193 countries, including the Russian Federation, and more than 900 companies.

- *Intermediate skills* - enable us to use digital technologies in even more meaningful and beneficial ways, including the ability to critically evaluate technology or create content.
- *Advanced skills* - are highly specialized abilities of the specialists in the field of ICT.

Furthermore, digital skills can be classified by areas of application:

- *Information skills* - identify, locate, retrieve, store, organise and analyse digital information, judging its relevance and purpose;
- *Communication skills* - communicate in digital environments, share resources through online tools, link with others and collaborate, interact through digital tools;
- *Problem solving skills* - identify digital needs and resources, make informed decisions which digital tools to use, solve problems through digital means, creatively use technologies, solve technical problems;
- *Software skills (for content manipulation)* - create and edit new content; integrate and re-elaborate previous knowledge and content; deal with and apply intellectual property rights and licenses.

On the basis of information about practices of the individual in the enumerated spheres of activities an integrated indicator 'individuals' level of digital skills' is estimate. It is used in practice of Eurostat[4] to characterize an overall level of digital skills of the population. The assessment is carried out on a following scale: no skills, low, basic, above basic. If the individual did not use the Internet during the last three month, his digital skills cannot be assessed (see details in Appendix 1).

In our analysis we estimate the effect of socio-demographic characteristics on the individuals' digital skills level, which is assessed using the indicators introduced by the international organizations:

- number of ICT skills by complexity: basic, professional, advanced (according to ITU),
- number of ICT skills by specific areas of application: : information and data literacy, communication and collaboration, digital content creation, problem solving (according to Eurostat),
- overall level of digital skills: total number of digital skills.

[4] https://ec.europa.eu/eurostat/cache/metadata/en/tepsr_sp410_esmsip2.htm

The overall digital skills indicator according to Eurostat methodology is used to make international comparisons.

Linear regression analysis was used for assessment of the impact of socio-demographic factors and professional characteristics. General form of the model estimates:

$$Y_M = \beta_i X_i + \epsilon \quad (1)$$

where Y_M is a dependent variable reflecting the level of digital skills, according to different approaches, β_i – is the coefficients of influence of independent variables, X_i is the independent variables.

27 dummy variables, which describe ICT practices of people, are used to calculate digital skills indicators. A list of variables is provided in Appendix 2.

The following independent variables were included in the model: socio-demographic characteristics (gender, level of education, type of place of residence, region of residence), professional characteristics (work experience, type of main job, occupation, sector of employment) and ICT infrastructure (access to personal computer, Internet at home).

Results

We start with the descriptive statistics of the overall digital skills level of the employed in Russia and in the EU countries. We try to reveal common and unique characteristics. Further, we estimate the effect of socio-demographic and professional characteristics on the individuals' number of digital skills level.

The average level of digital skills of the employed is higher than that of the whole population. This is typical for both EU countries and Russia (Figure 1). The share of the employed people without digital skills (including those who have not used the Internet in the last 3 months) in the EU member states constitutes 6% (vs 10% among the whole population). The share of the employed without digital skills in Russia is almost the same - 5% (vs 20% among the whole population). Moreover, the proportion of the employed with a level of digital skills above the basic level is higher: on average, 32% in the EU countries (6 p.p. higher than in the entire population) and in Russia - 17% (5 p.p. higher than in the entire population). The level of digital skills of the employed is lower in Russia than in the EU countries.

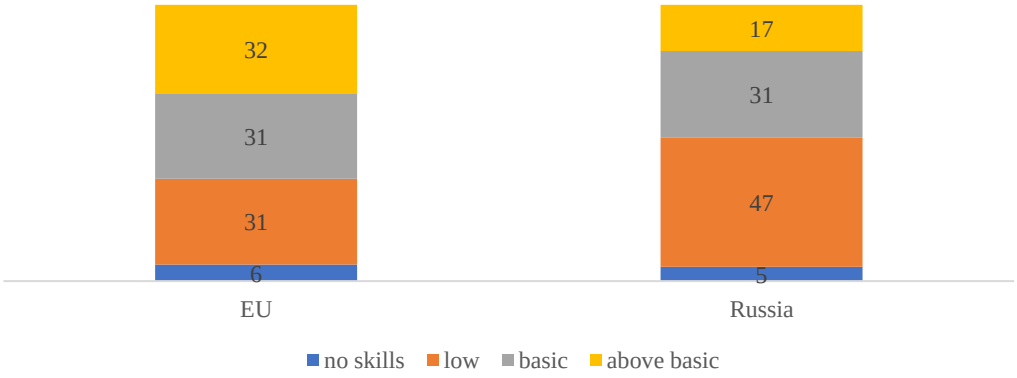

Fig. 1. Structure of the employed people in Russia and the EU by the overall digital skills level in 2021, %
Source: Authors' estimates, Rosstat and Eurostat data

The share of workers with digital skills of "basic level and higher" in Russia is significantly lower (Figure 2). In 2021 the share of this group in Russia was 48%, which is comparable with North Macedonia (48%) and Poland (53%) and 15 p.p. lower than the EU average. While in the Scandinavian countries (Norway, Sweden, Finland), Iceland, the Netherlands, Ireland and Switzerland at least 80% of the employed had basic and higher level of digital skills.

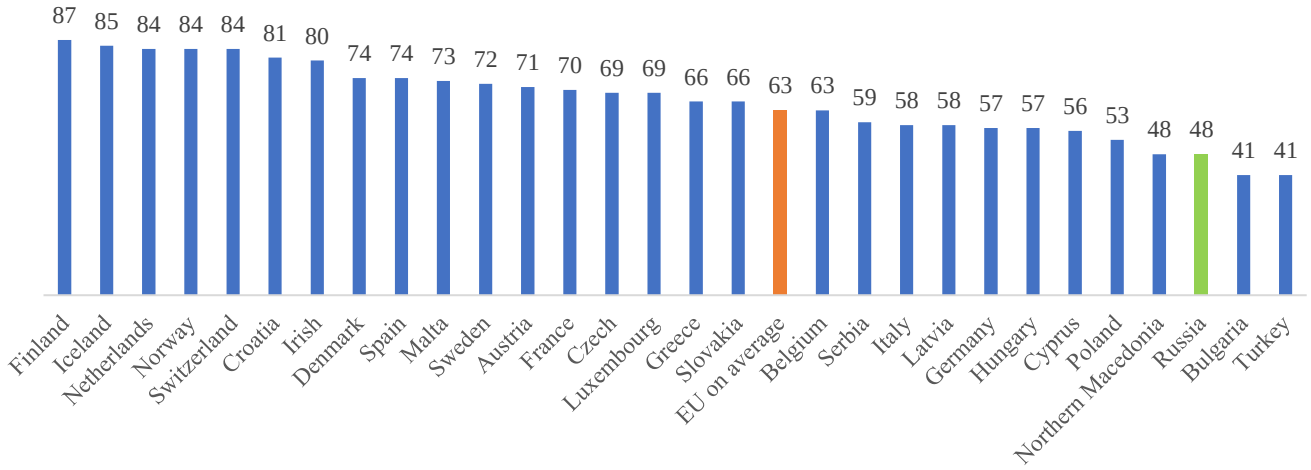

Fig. 2. Percentage of the employed with basic or above basic level of digital skills in 2021, %
Source: Authors' estimates, Rosstat and Eurostat data.

The share of workers without digital skills in Russia has been declining during the last 5 years: it has decreased from 14% in 2017 to 5% in 2021 (Figure 3). But the largest increase has been observed in the group of those who possess low level of digital skills: from 39% to 47%. At the same time the share of workers with the highest level of digital skills (above basic) has grown by 3 p.p.

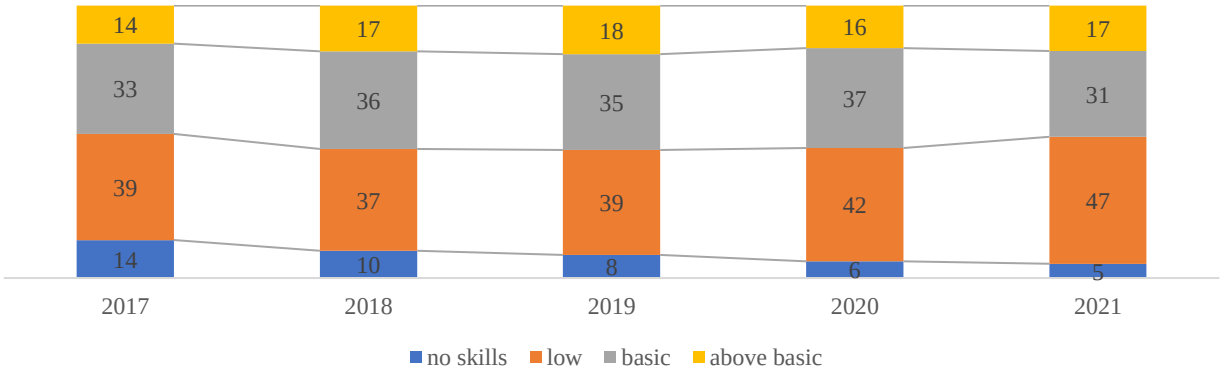

Fig. 3. Structure of the employed people in Russia by the overall digital skills level in 2017 - 2021, %

Source: Authors' estimates, Rosstat data

The level of digital skills of the employed varies by socio-demographic groups. Thus, the level of digital skills of women is higher than that of men in Russia: for example, the proportion of women with an above basic level of digital skills is 4 p. p. higher than that of men (19% and 15%, respectively). For men, the most common category of digital skills is "below the basic level" (52%, which is 11 p. p. higher than for women). Among the employed men 6% do not have digital skills, while among women - only 4%. There are also differences in the digital skills level among urban and rural workers: in urban areas 53% of workers have basic and above basic levels of digital skills, among rural residents - 31%. The younger population has, on average, a higher level of digital skills. Furthermore, the higher level of education of the individual, the higher the level of digital skills (Figure 4). 31% of the employed with higher education have above basic level of digital skills and 40% have a basic level. Among people with vocational education only 11% have above basic level of digital skills, 30% - the basic level. Among employed with secondary education (and below) only a quoter had basic and above basic level of digital skills.

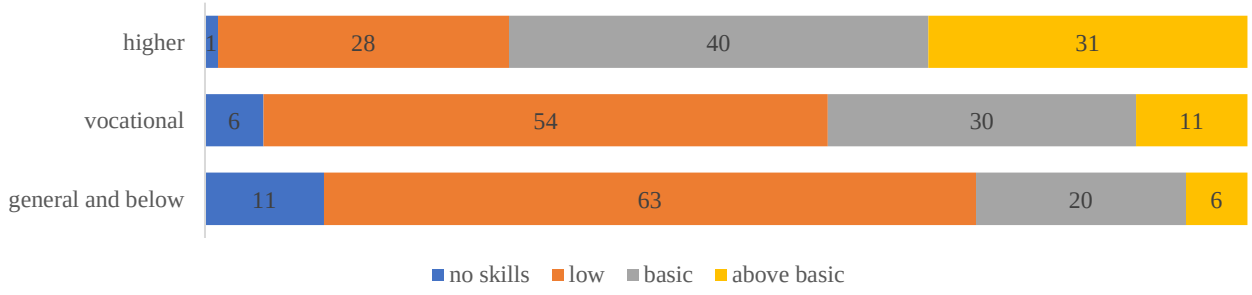

Fig. 4. Structure of the employed people in Russia by the level of education and the overall digital skills level in 2021, %

Source: Authors' analysis, Rosstat data

The level of digital skills varies by professional groups (Figure 5). ICT specialists have the highest level of digital skills: more than half of them have digital skills above the basic level (53%), which is 18 p.p. higher than in other occupations associated with intensive use of ICT and 42 p.p. higher than in all other occupations. The structure of ICT specialist by digital skills level in Russia is close to the structure in Europe (52% - above basic; 25% - basic; 20 – low).

A high share of ICT specialists with basic and low levels of digital skills can be explained by several reasons. On the one hand, this group of workers include not only professionals, but also technicians and qualified workers, the enumerated groups differ by their qualification level. On the other hand, the indicator of the overall digital skills level covers not only professional ICT skills, but also basic ICT skills (such as using a messenger or buying things online).

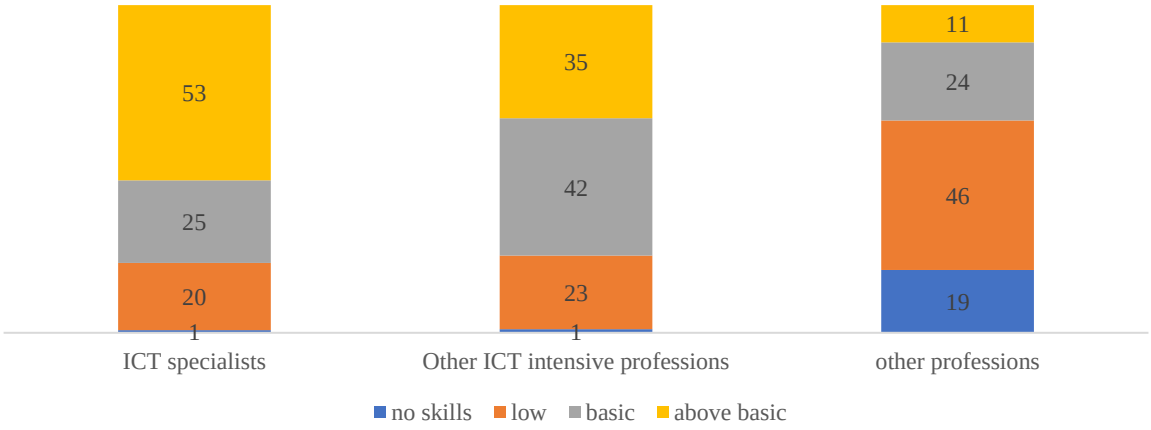

Fig. 5. Structure of the employed people in Russia by occupations and the overall digital skills level in 2021, %
Source: Authors' analysis, Rosstat data

The influence of characteristics on individuals' digital skills.

In this section we estimate the influence of various characteristics on the level of digital skills of the employed. Firstly, we analyze the impact on digital skills classified by their complexity, secondly, by spheres of specific activity and, thirdly, the analysis of the influence on the aggregate estimate of digital skills level.

a) Digital skills by complexity (ITU approach)

OLS regression analysis is implemented to estimate the impact of socio-demographic and professional characteristics on basic, intermediate, advanced digital skills. The results are presented

in table 1. The variables included in the model explain a third of the variation in the number of basic-level digital skills (R^2 = 0.32, Adj R^2= 0.32). The model has less explanatory power for intermediate (R^2= 0.15, Adj R^2 = 0.15) and advanced digital skills (R^2= 0.13, Adj R^2= 0.13).

Socio-demographic characteristics make the most significant contribution to the development of basic digital skills (Table 1).

The inverse relationship between age and the level of digital skills has been confirmed: the older the age, the less basic digital skills a worker has. People aged 15-24 have +2,2 basic skills, +1,4 intermediate skills and 0,12 advanced skills more than employed at the age of 55 and older. Men have less basic digital skills than women (-1), but on the average more intermediate (+0,07) and advanced skills (+0,06).

Our results indicate that the growth in the level of education has a positive influence at the number of all types of digital skills: employed with higher education have +2,67 basic skills, +1,24 intermediate skills and +0,08 advanced skills to the level of people with general (and lower) level of education. It should be noticed that there is no significant difference in quantity of advanced skills between people with secondary and general (and lower) level of education.

Employed people who live in cities have more basic (+1,06), intermediate skills (+0,28) and advanced (0,03) digital skills than those who live in rural areas. There is also variation by region, where a person works: Moscow and Moscow region determines possession of +1,35 basic skills, +0,78 intermediate skills and +0,04 advanced skills to the level of those who live in regions without cities with a population of more than 1 million people. Living in St Petersburg and Leningrad region has a significant positive impact on the number of basic and intermediate digital skills.

Professional characteristics also play an important role, but their influence is not so high for the development of basic digital skills: the coefficients of the variables indicating work as an ICT specialist, in ICT sector or as an entrepreneur are significant but affect less than other enumerated characteristics. Working as an ICT specialist or in other professions associated with intensive ICT usage as well as employment in ICT sector has a stronger effect on the number of intermediate and advanced digital skills. Place of main work has a significant impact on the number of basic digital skills: employed in the sphere of entrepreneurial activity (without a status of a legal entity) have more (+1,37) basic, intermediate (+ 0,36) and advanced (+ 0,03) skills than people involved in production of goods in their own households for sale or exchange.

Tab. 1. Results of Digital Skills assessment regression (ITU approach)

Independent variables	Basic		Intermediate		Advanced	
	Coef.	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Age (base category -55 and older)						
15-24	2,20***	0,054	1,40***	0,038	0,12***	0,006
25-34	1,83***	0,036	0,87***	0,025	0,08***	0,004
35–44	1,36***	0,033	0,46***	0,023	0,04***	0,004
45-54	0,86***	0,034	0,24***	0,024	0,02***	0,004
Gender: Male	-0,99***	0,022	0,07***	0,016	0,06***	0,003
Level of education (base category – General and lower)						
Higher	2,67***	0,057	1,24***	0,041	0,08***	0,007
Vocational	1,12***	0,054	0,33***	0,038	0,01**	0,006
Secondary	0,49***	0,058	0,13***	0,041	-0,00	0,007
Type of accommodation: urban	1,06***	0,024	0,28***	0,017	0,03***	0,003
Experience, years	-0,002***	0,0004	0,00	0,000	0,00	0,000
Type of region of residence (base category – Regions without cities with a population of more than 1 million)						
Moscow and the Moscow region	1,35***	0,042	0,78***	0,029	0,04***	0,005
St. Petersburg and Leningrad Region	0,97***	0,055	0,47***	0,039	-0,01	0,006
regions with cities with a population of more than 1 million people, except Moscow and St. Petersburg	0,18***	0,027	-0,07***	0,019	-0,01***	0,003
Place of main work (base category – production of products in household for sale or exchange)						
Enterprise, in an organization with the status of a legal entity	0,94***	0,092	0,14*	0,065	0,001	0,011
Entrepreneurial activity without a status of a legal entity	1,37***	0,102	0,36***	0,073	0,03**	0,012
Work for individuals, individual entrepreneurs	0,61***	0,096	-0,03	0,068	0,003	0,011
Occupation (base category - professions which are NOT associated with the intensive use of ICT)						
ICT specialists	1,17***	0,088	1,93***	0,062	0,74***	0,010
Employed in other ICT-intensive occupations	0,78***	0,04	0,44***	0,029	0,04***	0,005
Work in the ICT sector	0,48***	0,104	0,79***	0,074	0,29***	0,012
Has a personal computer in the household	2,002***	0,035	0,77***	0,024	0,05***	0,004
Has the Internet in the household	2,54***	0,065	0,02	0,046	-0,04	0,008
Constant	-1,80***	0,112	-0,78***	0,079	-0,08***	0,013

Notes: The range of dependent variables is 0-16 basic level skills; 0-6 intermediate level skills; 0-3 advanced level skills. *** –p <0.01; ** –p <0.05

Our results indicate that access to personal computer in the household have a strong positive affect on the number of all types of digital skills: basic (+2), intermediate (+ 0,77), advanced (+0,05). At the same time, the presence of the Internet in the household influences only on the basic digital skills (+2,56).

Thus, the role of socio-demographic characteristics decreases with the rise of complexity of digital skills, while the role of professional characteristics becomes stronger. The impact of most infrastructure characteristics on the basic skills is rather high, while for the advanced characteristics is almost imperceptible.

b) Digital skills in four specific areas (information, communication, problem solving, software skills)

The results of regression analysis presented in table 2 indicate the impact of socio-demographic and professional characteristics on the number of digital skills in specific areas: information, communication, problem solving and software skills. The variables included in the model explain a quarter of the variation in the number of digital communication skills ($R^2 = 0,25$, Adj $R^2 = 0,25$). The model has less explanatory power for information ($R^2 = 0,24$, Adj $R^2 = 0,24$), problem solving ($R^2 = 0,24$, Adj $R^2 = 0,24$) and software ($R^2 = 0,25$, Adj $R^2 = 0,25$) skills.

Direction of influence of independent variables on the number of digital skills in different specific areas is the same with the discussed above. However, each specific sphere has some peculiarities. Variation of information skills is mostly explained by the level of education and ICT infrastructure of the household: employed with higher education have more information skills (+0,89) than people with general (and lower) level of education; availability of the Internet in the household increases the number of information skills by 0,82 and the presence of a personal computer in the household raise by 0,73.

Communication skills are more dependent on the age of the people and the presence of the Internet and computer in the household. Young people have more communication skills: employed at the aged of 15-24 have 0,8 more skills than workers aged 55 and older (other things being equal). Availability of the Internet in the household magnifies the number of communication skills.

Problem solving skills strongly depend on the occupation of the respondent: number of problem-solving skills of ICT specialists are 0,96 points larger than of the employed in occupations not associated with intensive use of ICT. Also, young age and higher education have a great impact at the number of problem-solving skills: people aged 15-24 have +0,94 skills to the level of people older than 55 years and individuals with higher education have +0,7 digital skills than people with

Tab. 2. Regression results of digital skills competence assessment

Independent variables	Information skills		Communication skills		Problem solving skills		Software skills	
	Coef.	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Age (base category -55 and older)								
15-24	0,56***	0,023	0,80***	0,018	0,94***	0,019	0,79***	0,018
25-34	0,51***	0,015	0,69***	0,012	0,71***	0,013	0,43***	0,012
35–44	0,39***	0,014	0,51***	0,011	0,50***	0,012	0,24***	0,011
45-54	0,26***	0,014	0,31***	0,011	0,31***	0,012	0,12***	0,011
Gender: Male	-0,47***	0,010	-0,19***	0,007	-0,12***	0,008	-0,25***	0,008
Level of education (base category – General and lower)								
Higher	0,89***	0,025	0,50***	0,019	0,70***	0,020	0,92***	0,019
Vocational	0,37***	0,023	0,32***	0,018	0,31***	0,019	0,24***	0,018
Secondary	0,17***	0,025	0,17***	0,019	0,12***	0,020	0,08***	0,019
Type of accommodation: urban	0,41***	0,010	0,18***	0,008	0,30***	0,009	0,14***	0,008
Experience, years	-0,0005***	0,000	-0,0004***	0,000	-0,0007***	0,000	0,0003*	0,000
Type of region of residence (base category – Regions without cities with a population of more than 1 million)								
Moscow and the Moscow region	0,62***	0,018	0,08***	0,014	0,42***	0,015	0,34***	0,014
St. Petersburg and Leningrad Region	0,21***	0,024	0,18***	0,018	0,15***	0,020	0,20***	0,019
regions with cities with a population of more than 1 million people, except Moscow and St. Petersburg	0,18***	0,011	0,03***	0,009	-0,06***	0,009	0,02**	0,009
Place of main work (base category – production of products in own household for sale or exchange)								
Enterprise, in an organization with the status of a legal entity	0,28***	0,039	0,30***	0,030	0,24***	0,032	0,17***	0,031
Entrepreneurial activity without a status of a legal entity	0,40***	0,044	0,40***	0,034	0,44***	0,036	0,20***	0,034
Work for individuals, individual entrepreneurs	0,17***	0,041	0,26***	0,031	0,18***	0,034	0,004	0,032
Occupation (base category - professions which are NOT associated with the intensive use of ICT)								
ICT specialists	0,33***	0,038	0,18***	0,029	0,96***	0,031	0,83***	0,029
Employed in ICT-intensive occupations	0,25***	0,017	0,09***	0,013	0,19***	0,014	0,36***	0,014
Work in the ICT sector	0,17***	0,045	0,07*	0,034	0,38***	0,037	0,33***	0,035
Has a personal computer in the household	0,73***	0,015	0,63***	0,011	0,61***	0,012	0,47***	0,012
Has the Internet in the household	0,82***	0,028	1,35***	0,021	0,51***	0,023	0,04**	0,022
Constant	-0,55***	0,048	-0,46***	0,037	-0,67***	0,040	-0,30***	0,037

Notes: The models have passed all the tests for limitations. F-model statistics = 0,000 *** – correlation coefficient is reliable, p <0.01; ** – correlation coefficient is reliable, p <0.05.

general (or lower) education. The same factors determine the number of software skills. Employed with higher education have 0,92 more software skills than people with general and lower level of education. Moreover, ICT specialists have 0,83 more software skills than people employed in occupations which are not associated with intensive usage of ICT.

Thus, socio-demographic characteristics have a great influence at the number of digital skills in different specific areas. The level of education has the large effect on all groups of skills. Men on average tend to have less digital skills in all application areas. The inverse relationship between age and the level of digital skills exists for all groups of digital skills: the higher the age, the less digital skills an individual has (especially for software skills). ICT infrastructure has the largest significant impact on the level of informational and communication digital skills, while professional characteristics significantly influence on the number of problem solving and software skills**.**

c) Overall digital skills level

Regression analysis is implemented to assess the impact of socio-demographic and professional characteristics on the total number of digital skills. The results are presented in table 3. The variables included in the model explain more than a third of the variation in the number of general digital skills ($R^2 = 0.374$ and Adj $R^2 = 0.374$).

Socio-demographic characteristics have the greatest contribution to the digital skills development. The level of education is a key predictor of the total number of digital skills: the higher the level of education, the larger number of skills. Also, living in cities, especially in Moscow and the Moscow region, has a positive impact on the indicator of the total number of digital skills. The inverse relationship between the age and the number of digital skills has been confirmed (the older a person is, the less ICT skills he has). It is confirmed that women have more digital skills than men.

ICT infrastructure significantly affects the indicator: possession of a personal computer and Internet in a household positively influences at the number of digital skills. Professional characteristics impact less than socio-demographic characteristics, but their influence is significant. Employment as an ICT specialist has still quite a strong influence. The inverse relationship between the experience and the number of digital skills has been confirmed.

Tab. 3. Regression results of general digital skills assessment (Sum approaches)

Independent variables	Amount indicator	
	Coef.	**Std. Err.**
Age (base category -55 and older)		
15-24	4,12***	0,089
25-34	3,08***	0,059
35–44	2,07***	0,055
45-54	1,25***	0,055
Gender: Male	-0,91***	0,037
Level of education (base category – General and lower)		
Higher	4,38***	0,094
Vocational	1,64***	0,089
Secondary	0,68***	0,095
Type of accommodation: urban	1,45***	0,040
Experience, years	-0,002**	0,001
Type of region of residence (base category – Regions without cities with a population of more than 1 million)		
Moscow and the Moscow region	2,39***	0,068
St. Petersburg and Leningrad Region	1,55***	0,091
regions with cities with a population of more than 1 million people, except Moscow and St. Petersburg	0,08*	0,044
Place of main work (base category – production of products in own household for sale or exchange)		
Enterprise, in an organization with the status of a legal entity	1,19***	0,151
Entrepreneurial activity without a status of a legal entity	1,95***	0,169
Work for individuals, individual entrepreneurs	0,66***	0,157
Occupation (base category - professions which are NOT associated with the intensive use of ICT)		
ICT specialists	4,08***	0,144
Employed in ICT-intensive occupations	1,35***	0,067
Work in the ICT sector	1,65***	0,171
Has a personal computer in the household	3,34***	0,057
Has the Internet in the household	2,84***	0,107
Constant	-2,93***	0,184

Notes: The model has passed all tests for limitations. F-model statistics = 0,000 *** – the correlation coefficient is reliable, p <0.01; ** – the correlation coefficient is reliable p < 0.05.

Conclusion

In this paper influence of socio-demographic and professional characteristics of the employed in Russia on the level of digital skills was considered. To achieve research goal, an analysis of the literature devoted to the conceptualization of digital skills and describing the factors influencing the level of digital skills was carried out. The conceptual framework for analysis of digital skills was formed. Analysis was based on the representative Rosstat sample surveys. Data for 2021 was used. The impact of various characteristics on the level of digital skills was assessed using different approaches to measuring digital skills (according to the complexity, the specific area of application and the total number).

It was revealed that socio-demographic characteristics of a person affect almost all types of digital skills. But they mostly determine the development of less complex digital skills which can be obtained during life. While professional characteristics largely determine more complex skills, for example, software skills, which require special training or education. It is worth noting that ICT infrastructure accessible for the employed also makes a significant contribution to the number of digital skills. Having a personal computer and the Internet in the household affects all digital skills.

It also revealed that the effect of characteristics varies for digital skills from different specific areas of application. Information and communication skills are acquired during life and are used not only in the working environment, therefore, the influence of socio-demographic characteristics on their level is greater than that of professional characteristics. On the other hand, the skills of problem solving and working with software are largely involved in the working process, professional characteristics of the employed (especially employment in the ICT sector or intensive use of ICT at work) largely determine the number of these types of skills.

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Appendix 1

Description of digital skills types according to the Eurostat approach

Information skills – the ability of a person to form the need for information and the skills to search, extract, store, manage and organize digital information.

Communication skills – the ability of a person to interact with other people using digital technology, as well as to participate in the social and cultural life of society while preserving their digital identity and reputation.

Problem solving skills – the ability of a person to identify problems, as well as the ability to solve problems in a digital environment.

Software skills (for content manipulation) – the ability of a person to create and edit digital content using specialized software.

Overall level of digital skills – knowledge and skills that a person possesses to use ICT to achieve goals in his personal and professional life. The algorithm for evaluating the indicator is as follows. First, the actions that the respondents performed during a certain period of time are selected (they are encoded as binary variables 1-performed an action, 0-did not perform an action). Second, the values are added together, the level of each skill group is determined by the sum: 0 – no skills, 1 – basic level, 2 or more – above the basic level. To determine the overall level of digital skills, assessments are used in 4 areas. As a result, an assessment of the overall level of digital skills is formed: 0 – no digital skills; 1 – below the basic level; 2 – basic level; 3 – above the basic level.

Appendix 2

List of variables included in digital skills indicators

Variable	Description of the variable	Basic skills indicator ITU	Intermediate Skills indicator ITU	Advanced Skills Indicator ITU
1	2	5	6	7
C4_1	Working with a text editor	Software skill	-	-
C4_2	Working with spreadsheets	-	Software skill	-
C4_3	Using programs for editing photo, video and audio files	-	Software skill	-
C4_4	Creation of electronic presentations using special programs	-	Software skill	-
C4_5	Connecting and installing new devices	-	Is not used	-
C4_6	Self-writing software or codes/commands using programming languages	-	-	Software skill
C4_7	File transfer between a computer and other devices, including using services such as Yandex.Disk, Cloud Mail.Ru , Google Drive, Dropbox, iCloud and others	-	-	-
C4_8	Search, download, install and configure software	-	-	Problem solving skill
C4_9	Installing a new or reinstalling the operating system	-	-	Problem solving skill
C4_11	Sending messages by e-mail, via messengers, via SMS with attached file(s)	-	-	-
C4_12	Copying or moving a file or folder	Information skills	-	-
C4_13	Using a copy and paste tool to duplicate or move data, information or other materials (text, photo, video, audio files), for example, in a document, between devices	Is not used	-	-
Int5_1	Search for information about goods and services	Information skills	-	-
Int5_2	Search for information related to health or health services	Information skills	-	-

Int5_4	Sending or receiving email	Communication skills	-	-
Int5_5	Phone calls or video conversations over the Internet	Communication skills	-	-
Int5_6	Participation in social networks	Communication skills	-	-
Int5_7	Participation in online voting or consultations on public and political issues	Is not used	-	-
Int5_8	Publication of opinions on public and political issues through websites, participation in forums	Is not used	-	-
Int5_12	Implementation of banking operations	Problem solving skill	-	-
Int5_14	Distance education	-	Problem solving skill	-
Int5_15	Obtaining knowledge and references on any topic using Wikipedia, an online encyclopedia or other similar source of information	Is not used	-	-
Int5_18	Downloading software	-	-	Problem solving skill
Int5_21	Uploading personal files to any websites, social networks for public access	-	Information skill, Communication skills	-
Int5_24	Buying goods or services online	Problem solving skill	-	-
Int5_25	Sale of goods or services on the Internet	Problem solving skill	-	-
PS3_1	Obtaining information through official websites and portals of state and municipal services	Information skills	-	-

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