New Dimensions of Functional Illiteracy in the Digital Economy

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Abstract. We explore the new aspects of functional illiteracy associated with the inability to seamlessly fit into the new economic reality that requires mastering skills and technologies adequate to the digital economy. Data on the level of computer literacy and web accessibility for different categories of population is used as basic indicators of readiness to use digital technology in everyday life and in the workplace. The study shows that about one third of the adult population in Russia is at risk of functional illiteracy. Older cohorts, low-educated people from low-income households, and rural dwellers are the most vulnerable groups. The regional factor makes an additional contribution to the digital divide. We argue that special measures and programs to overcome digital illiteracy targeted at population groups in high-risk geographic areas should be developed. The article is based on the data from the Comprehensive Survey of Living Conditions conducted by Rosstat and the Federal Statistical Survey on the Use of Information Technology.
Keywords: digital economy, functional illiteracy, computer literacy, the Internet, digital divide.

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A pivotal trend in modern socioeconomic development is the active digitalization of the most diverse aspects of societal life marking the onset of the so-called digital economy [IMF 2018]. A country's ability to fit into this trend successfully is largely determined by the so-called "national human potential". The problem of adjusting this potential to the new requirements is multifaceted, the most obvious facet being the need for expanded reproduction of experts in information infrastructure creation and maintenance. Of no less importance, however, is how the people at large will adapt to the new reality. The threat of functional illiteracy is looming as technology advances in quantum leaps, not only revolutionizing data transfer, search, and processing but also fundamentally transforming the relationship mechanisms of both the labor market and the satisfaction of material and social needs.

Translated from Russian by I. Zhuchkova.

The Modern Concept of Functional Illiteracy

The concept of functional illiteracy was adopted by the scientific community in the late 1970s, when it became evident that a substantial share of population in the developed countries was unable to solve the problems arising in their increasingly complicated everyday life, e. g. understand medication and technical instructions, compare prices and read ingredients in the supermarket, or fill out utility bills. According to UNESCO, "a person is functionally literate who can engage in all those activities in which literacy is required for effective functioning of his group and community and also for enabling him to continue to use reading, writing and calculation for his own and the community's development" [UNESCO 1978:183]. Initially, therefore, the problem concerned low-educated people who, while not being illiterate in a strict sense, had serious deficiencies in the level and structure of their traditional basic skills [Levine 1982; Lankshear 1985; Chudinova 1994].

Today, the situation is radically changing. The rise of the digital economy requires that not only working population but every member of society possess a fairly wide range of new generation skills built around computer literacy. In this context, the concept of functional literacy must be reconsidered and extended. More and more researchers of the new millennium use terms like computer literacy [McCade 2001; Talja 2005], functional Internet literacy [Johnson 2007], and ICT literacy [Lynch 1998; International ICT Literacy Panel 2007]. The authors of the report *Digital Transformation. A Framework for ICT Literacy* define ICT literacy as the ability to use digital technology, communications tools, and networks to access, evaluate, disseminate, and create information, noting that "the notion of a literate populace must be expanded to include the technology-based skills and abilities that will enable citizens to function in an increasingly technological world" [International ICT Literacy Panel 2007:1, 2].

In today's world, therefore, functional illiteracy acquires a considerably larger scale, affecting well-educated social groups with human capital of the pre-digital era who are unable to seamlessly fit into the new economic reality that requires mastering skills and technology adequate to the digital economy.

The Evolution of ICT Literacy in Russia

Three rounds of the Comprehensive Survey of Living Conditions (CSLC) conducted by the Federal State Statistics Service (Rosstat) in 2011, 2014 and 2016[1] are used to measure the depth of the functional illiteracy problem in Russia and get an insight into the pace of transformations. The study also uses the results of the 2016 Federal Statistical Household Use of Information Technology (FSHUIT) Survey[2]. Data on the level of computer literacy and web accessibili-

[1] http://www.gks.ru/free_doc/new_site/inspection/itog_inspect1.htm
[2] http://www.gks.ru/opendata/dataset/7708234640-ikt2016-v01

Table 1. **The Increasing Percentage of Adult Population aged 15–72 with Computer Skills and Internet Access** (%)

	2011	2014	2016	2016/2011
Percentage of population with computer skills	56.9	63.3	70.1	1.23
Percentage of population with Internet access	51.3	63.0	70.9	1.38

Calculated based on the 2011, 2014, and 2016 CSLC data.

ty for different categories of population is used as basic indicators of readiness to use digital technology in everyday life and in the workplace.

The CSLC statistics indicate a rapid expansion of the percentage of population possessing at least the basic skills and opportunities necessary to function in a digital economy. Both measures of "digital maturity"—computer skills and web accessibility—were below the level of statistical significance in Russia in 1992, but in 2011 over half of the adult population had ICT skills and access to the Internet (Table 1). The levels of computer literacy and Internet literacy increased by 13 and 19 percent, respectively, between the first and the third CSLC rounds. In 2016, about 70 percent of the population aged 15–72 had computer skills and access to the web.

Because the growth rate of web accessibility is higher than that of computer literacy, it may be assumed that basic computer skills, not access to the Internet, are what inhibits the use of digital technology in Russia. The reported reasons for having no home internet confirm this assumption indirectly: only around five percent of the households without web access explain it by high prices or infrastructural deficiencies. The vast majority of the non-users say that they have no need for the Internet, which may indicate an underdeveloped demand for digital technology caused by low computer literacy.

Data from Rosstat's FSHUIT Survey allows evaluating not only the incidence of the basic skills but also the level of computer literacy. As can be seen from Figure 1, only a little over 40 percent of the population have word processing skills. The next most widespread skill (29%) is transferring files between the computer and peripheral devices, such as digital camera, audio player, or mobile phone. Only 20 percent of the adult population know how to work with spreadsheets and edit photo, video and audio files, and hardly one citizen out of ten is able to connect new devices to the computer or create electronic presentations. Therefore, the best part of Russian Internet users have only mastered the very basic computer skills.

Cross-national assessments of the basic indicators of adapting to the use of digital technology reveal that Russia is falling behind the most advanced economies. According to the Programme for the Inter-

Figure 1. **Shares of Population with Specific Computer Skills** (%)

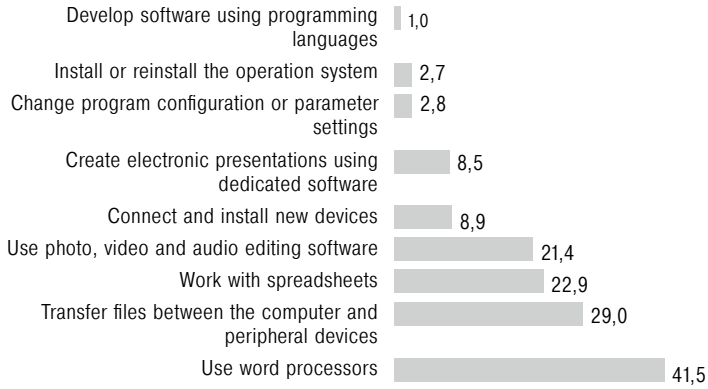


Table 2. **Levels of Adult Adaptation to the Digital Economy in Individual Countries**

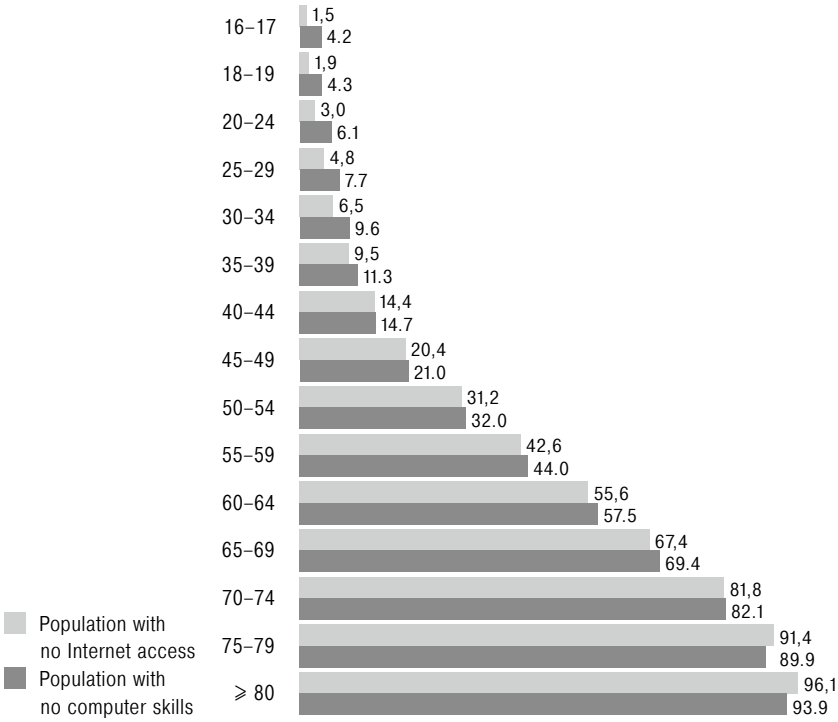
Category	Share of respondents (%)				
	OECD	Norway	USA	Greece	Russia
Refused the computer-based assessment	9.6	6.7	6.3	11.2	12.8
No computer experience	10.0	1.6	5.2	17.4	18.3
Failed the core ICT test required to participate in tests for problem-solving in technology-rich environments	4.7	5.2	4.1	2.8	2.5
Below Level 1	14.2	11.4	15.8	22.4	14.9
Level 1	28.7	31.8	33.1	25.5	25.6
Level 2	25.7	34.9	26.0	11.5	20.4
Level 3	5.4	6.1	5.1	2.5	5.5

Based on the PIAAC data.

national Assessment of Adult Competencies (PIAAC)[3], the percentage of adults who refused the computer-based assessment in Russia was nearly 25 percent higher than the OECD average and twice as high as in the top-ranked countries. The share of citizens with no computer experience in Russia is comparable to that of the OECD "underachievers", Greece being a typical example. At the same time, the proportion of digital-savvy population (reaching Levels 2 and 3) is pretty much meeting the standards set by the top-rankers (Table 2).

[3] http://www.oecd.org/skills/piaac/

Figure 2. **Shares of Population with No Computer Skills vs. No Internet Access in Different Age Groups, 2016** (%)



Skills and opportunity to use the advantages of the digital economy are distributed rather unevenly across the different social classes and groups in Russia. Considerable differences are observed as a function of sociodemographic characteristics as well as the external factors including income level and geographic location.

ICT Literacy Age Structure

The extremely rapid development of digital technology, its integration into learning and everyday life give a competitive edge to youngsters as the cohort most actively accumulating human capital and responding flexibly to changes in the outside world. For this reason, there is a very distinct relation between age and the degree of adaptation to the digital economy.

According to the CSLC, the average age of the respondents with computer skills was 39.9 in 2016 while the average age of those without computer experience was 64.5 years. As illustrated in Figure 2, computer literacy is inversely related to age, young people being much more likely to have computer skills than middle-aged adults and, even more so, older adults. Less than two percent of 16- to 19-year-

Table 3. **Computer Skills in Different Age Groups** (%)

Skill	Share of respondents aged					
	15–24	25–34	35–44	45–54	55–64	65–72
Use word processors	64.4	50.2	46.3	38.5	23.5	9.1
Work with spreadsheets	39.7	28.4	25.4	21.1	10.2	2.5
Use photo, video and audio editing software	40.3	30.2	22.6	14.9	8.3	3.4
Create electronic presentations using dedicated software	23.6	9.5	7.5	5.5	2.3	0.4
Connect and install new devices	16.1	13.3	9.4	6.3	3.1	0.9
Develop software using programming languages	2.2	1.7	1.0	0.5	0.2	0.1
Transfer files between the computer and peripheral devices	48.1	41.0	32.8	22.5	11.7	4.2
Change program configuration or parameter settings	5.4	4.6	2.9	1.7	0.8	0.3
Install or reinstall the operation system	5.0	4.7	2.8	1.6	0.7	0.2

Based on the FSHUIT Survey.

olds reported having no computer skills in 2016. The proportion is gradually increasing with age, reaching 49.5 percent among the population aged 55–59 and accounting for over half of those aged 60–64.

Web accessibility is also strongly related to respondent age. Less than five percent of 16- to 19-year-olds had no access to the Internet, as compared to one out of every ten in the age group 30–39 and an overwhelming majority of the respondents aged over 60.

The FSHUIT Survey statistics show that the range of computer literacy skills is also steadily shrinking with age. The youngest age cohorts are much more likely to possess nearly all sorts of skills from basic to the most complex ones, such as changing program configuration settings and developing software (Table 3).

As we can see, it is mainly older adults who are responsible for the relatively low rates of computer literacy and web accessibility in Russia. According to the CSLC, population above the working age accounts for about two thirds of the respondents without computer skills (67.2%). The increase in adult computer literacy between the rounds was largely due to the fact that youth cohorts, well-adapted to the digital economy, had reached the working age. The problem of ICT illiteracy is thus expected to gradually subside with the change of generations, even if no targeted adaptation programs are developed. However, this is a very slow process, and the passive waiting strategy ignores the need to adapt the vulnerable groups—which are not restricted to the elderly, as it will be shown below.

Table 4. **Percentages of Male and Female Respondents with No Computer Skills and No Internet Access in Different Age Groups** (%)

	16–17	18–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80+
No computer skills															
Males	1.6	1.8	3.0	5.2	7.4	11.4	17.0	23.9	36.3	48.1	59.0	67.7	80.0	89.4	93.6
Females	1.3	1.9	3.0	4.4	5.8	8.0	12.1	17.5	27.2	38.7	53.3	67.2	82.8	92.2	96.9
Gender bias	0.3	–0.1	0.0	0.8	1.6	3.4	5.1	6.4	9.1	9.4	5.7	0.5	–2.8	–2.8	–3.3
No Internet access															
Males	4.4	3.8	6.2	8.0	10.2	13.0	17.1	23.2	34.9	45.4	56.5	67.0	79.7	87.8	93.5
Females	3.9	4.8	5.9	7.5	9.0	10.0	12.7	19.3	29.8	43.0	58.2	71.0	83.4	90.8	94.0
Gender bias	0.5	–1.0	0.3	0.5	1.2	3.0	4.4	3.9	5.1	2.4	–1.7	–4.0	–3.7	–3.0	0.5

Estimated based on CSLC-2016.

ICT Literacy Gender Structure

The widely held stereotype that women are less capable of succeeding in science, technology, engineering and math (STEM) disciplines than men allows hypothesizing a lower level of computer literacy in females. Indeed, the general adult population statistics indicate that women are more vulnerable to ICT illiteracy—35.2 percent of female respondents reported having no computer skills, as compared to 32.2 percent of male respondents. No access to the Internet was reported by 37.5 percent of women and 32.4 percent of men. The gender bias towards males is small but rather stable, the proportion of ICT-illiterate respondents being higher among women in all the three CSLC rounds.

However, age should be considered as the main determinant of computer literacy and web accessibility when analyzing the gender structure of functional illiteracy (Table 4). A small gender bias towards males in 2016 was only documented for 16- to 19-year-olds. In the rest of the cohorts, women were found to be better adapted to the digital economy.

The level of computer literacy is equally high among male and female teenagers. The decrease with age is typical of both genders but is much more conspicuous among men, which results in a gender bias towards women that peaks at pre-retirement age. Consequently, computer literacy rates are higher among women in most age cohorts, this

Table 5. **Computer Skills in Men and Women** (%)

Skill	Men	Women
Use word processors	38.6	44.0
Work with spreadsheets	20.6	24.9
Use photo, video and audio editing software	22.5	20.5
Create electronic presentations using dedicated software	7.8	9.1
Connect and install new devices	11.8	6.3
Develop software using programming languages	1.5	0.6
Transfer files between the computer and peripheral devices	30.8	27.4
Change program configuration or parameter settings	4.2	1.6
Install or reinstall the operation system	4.2	1.4

Based on the FSHUIT Survey.

tendency being typical of all the three CSLC rounds. The largest gender gap in computer literacy was observed for age 50–59 in 2011 and age 50–54 in 2014, being 9.1 percentage points in both cases. Therefore, higher average rates of digital literacy among men may be explained first of all by the differences in the age structure of male and female population. Life expectancy is longer for women than it is for men, so women's population features a higher share of the oldest age cohorts, least adapted to the new digital economy.

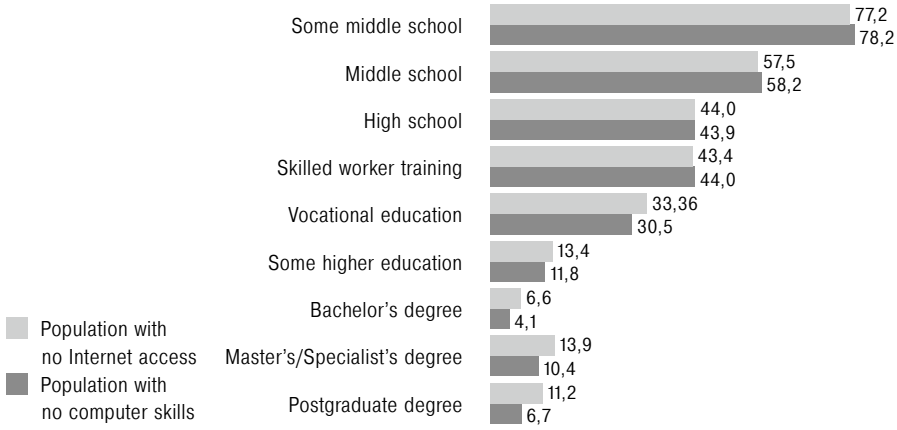
Additional information on the gender structure of computer literacy is provided by the FSHUIT Survey. As seen in Table 5, women are more likely to have such relatively common skills as using word processors, working with spreadsheets, and creating electronic presentations, while being essentially behind men on more complex and technology-based skills, such as changing program configuration settings and developing software.

Respondent age determines whether there is a gender bias in using the Internet, and its direction, the gender structure of web accessibility being similar to that of computer literacy. Yet, the bias towards women among the middle-aged population is not that significant as with computer literacy, and the change in bias direction occurs somewhat earlier (see Table 3).

ICT Literacy and Educational Attainment

There is a direct relationship between the level of computer literacy and the highest level of education completed by respondents (Figure 3). Among the college-educated, only 10 percent have no computer skills, being mostly represented by older adults who obtained higher education in the pre-digital era. Disturbingly, though, computer illiteracy is reported by four percent of Bachelor's degree holders—

Figure 3. **Shares of Population with No Computer Skills and No Internet Access in Groups with Different Levels of Educational Attainment, 2016** (%)



young people who are comparatively recent graduates (*Translator's note:* Bachelor's degree became part of Russia's Federal State Education Standards in 2010).

As educational attainment decreases, so does the level of computer literacy, gradually. Among respondents with vocational qualifications, 30.5 percent have no computer experience, and only one in five people with some middle school has computer skills. However, the share of ICT-illiterate population in this group has reduced as compared to the previous CSLC round (2014), when only 13.9 percent of the lowest-educated had computer skills.

Similar dependence on educational attainment is observed for web accessibility. In lower-educated groups, Internet access rates are approximately the same as computer literacy rates or even higher, while the situation is reverse for people with higher education. The percentage of computer users with no access to the Internet is only three percent among holders of Master's, Specialist's, and postgraduate degrees.

Effects of Income Level on ICT Literacy

The effects of household income on ICT literacy, too, should only be assessed through the prism of the age structure. According to the CSLC, the overwhelming majority (83.3%) of adult population with the lowest income[4] is within the working age[5], whereas the propor-

[4] Respondents in the first quintile of income, i. e. 20 percent with the lowest levels of household income.

[5] Most families are having children at the working age, which results in a high dependency load.

Table 6. **Shares of Population with No Computer Skills and No Internet Access in Groups with Different Income Levels** (%)

Age group	Category Based on Household Income			
	No computer skills		No Internet access	
	Lowest income*	Higher income**	Lowest income*	Higher income**
Under the working age	1.8	0.6	7.2	0.8
In the working age	22.3	11.2	25.2	11.9
Above the working age	79.2	65.7	73.7	67.8
Mean	30.5	35.2	32.2	36.5

* 1st quintile (the lower 20 percent).
* 2nd-5th quintiles (the higher 80 percent).
Source: Rosstat (estimated based on CSLC-2016).

tion of people above the working age, more vulnerable to ICT illiteracy, reaches 44.1 percent among citizens with higher incomes.

Table 6 demonstrates that low income has significant negative effects on both measures of adaptation to the digital economy in every age group. The effects are the most manifest at younger age and the least conspicuous at the retirement age. The Internet access gap among youths caused by differences in family income is the most disturbing factor of functional ICT illiteracy.

Geographic Differences in ICT Literacy

Socioeconomic and demographic differences between the regions of Russia are determined by the great diversity of ethnicities and faiths which are distributed unevenly across a vast territory. Despite the uniform national system of general and professional education, computer literacy rates differ dramatically across regions and types of localities.

The incidence of computer skills and Internet accessibility is essentially lower in rural areas than in cities, despite higher growth rates (Table 7). ICT literacy growth rates changed similarly in rural and urban areas between 2011 and 2016: the share of urban population with no computer experience decreased from 38.5 to 25.6 percent, rural from 56.4 to 42.7 percent. That is, the urban-rural gap reduced very little, from 17.9 to 17.1 percentage points. Computer illiteracy of adult population was found to be related directly to the size of locality, the lowest rates being typical of metropolises (20.7%) and the highest (53.6%) for rural areas with population of a few dozen people.

The situation is somewhat better with regard to the growth of web accessibility rates. During the same period, the percentage of non-In-

Figure 4. **Shares of Urban and Rural Population with No Computer Skills in Different Age Groups, 2016** (%)

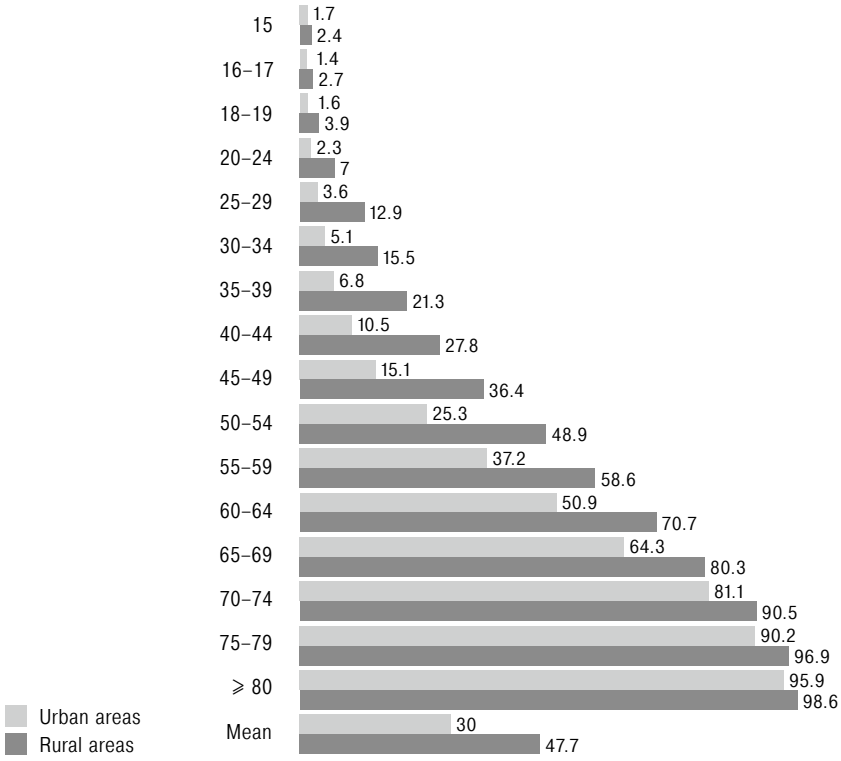


Table 7. **Shares of Adult Population with No Computer Skills and No Internet Access in Urban and Rural Areas** (%)

	2011			2016		
	Total	Urban	Rural	Total	Urban	Rural
No computer skills	43.1	38.5	56.4	29.9	25.6	42.7
No Internet access	48.7	43.2	64.7	29.1	24.4	43.3

Estimated based on CSLC2011, 2016

ternet users dropped from 43.2 to 24.4 percent in urban areas and from 64.7 to 43.3 in rural ones. Therefore, the urban-rural gap reduced from 21.5 to 18.9 percentage points, which is more significant in both absolute and relative terms. Nevertheless, the Internet access gap between urban and rural populations remains very large, exceeding the gap in computer literacy.

The age structure of rural and urban population, namely low numbers of youth and a high share of older cohorts in rural areas, adds

a lot to the urban-rural gap in computer literacy. It is seen in Figure 4 that lower levels of computer skills among rural respondents are typical of all age groups, but the difference is particularly striking in middle and older age. The computer literacy divide is relatively small between urban and rural youths aged under 25, the rates being fairly high in this age cohort, whereas the oldest groups demonstrate "equality of illiteracy". Obviously, the urban-rural gap will gradually diminish provided that current trends persist, but the process is going to be slow.

A similar pattern is observed in the inequality of access to the Internet.

Differences in computer literacy and web accessibility across regions are at least as significant as those between urban and rural populations. In 2016, there was a four-fold gap between the regions with the lowest and highest shares of non-computer users. As expected, the top positions are held by wealthy oil- and gas-producing regions and megacities with high proportions of well-educated urban citizens. Yamalo-Nenets Autonomous Okrug, where ICT illiteracy rate among the population aged 15 and over was only 12.4 percent in 2016, is ranked first, followed by Saint Petersburg (15.9%), Khanty-Mansi Autonomous Okrug—Yugra (16.6%), and Moscow (16.7%). Regions of European Russia with low-educated population and low youth, where nearly half of the adults have no computer skills—Penza Oblast (45.0%), Nizhny Novgorod Oblast (45.6%), Novgorod Oblast (46.2%), and Tambov Oblast (47.8%)—are ranked at the bottom.

Analysis of region-specific age structure of ICT literacy results in patterns similar to those observed for urban-rural differences: the gap between the top- and bottom-rankers is present virtually in every age group, being much smaller for younger generations than for older ones (Table 8).

Regional differences in web accessibility are similar to the regional structure of computer literacy (Table 9). The top three regions are Yamalo-Nenets Autonomous Okrug with only 13.8 percent of non-Internet users, Saint Petersburg, and Moscow (both 15.7%). Counterintuitively, again, the lowest rates of Internet connection are observed in rather densely-populated regions of European Russia—Tambov Oblast (47.9%) and Penza Oblast (48.9%)—and in one of the republics of the Northern Caucasus region, Dagestan (47.9%). The extremely high Internet inaccessibility rates in Dagestan are observed for all age groups, including youth, one in every five 15- to 29-year-olds being unable to use the Internet. With such age structure of the measure analyzed, it is most probably the demographic composition, i. e. a high percentage of youth, that prevented the region from being ranked the lowest. Relatively high ICT illiteracy rates among youth are also observed, although less prominently, in some other regions of the Northern Caucasus.

Because the data from the first CSLC round was not representative at the level of regions due to the small sample, this survey does

Table 8. **Shares of Population with No Computer Skills in the Top- and Bottom-Ranked Regions, by Age Groups** (%)

Age	Regions with the lowest shares of non-computer users			Regions with the highest shares of non-computer users		
	Yamalo-Nenets Autonomous Okrug	Saint Petersburg	Khanty-Mansi Autonomous Okrug	Nizhny Novgorod Oblast	Novgorod Oblast	Tambov Oblast
15–29	2.0	0.9	0.5	2.3	8.0	4.3
30–59	12.3	5.9	9.6	30.3	31.7	33.4
60 and over	43.1	56.1	58.7	84.6	86.2	85.0
Mean	12.4	15.9	16.6	45.6	46.2	47.8

Source: Rosstat (estimated based on CSLC-2016).

Table 9. **Shares of Population with No Internet Access in the Top- and Bottom-Ranked Regions, by Age Groups** (%)

Age	Regions with low shares of non-Internet users			Regions with high shares of non-Internet users		
	Yamalo-Nenets Autonomous Okrug	Saint Petersburg	Moscow	Tambov Oblast	Republic of Dagestan	Penza Oblast
15–29	1.3	0.7	0.2	5.1	20.8	3.7
30–59	13.2	5.8	5.0	34.0	45.6	33.7
60 and over	53.4	56.3	57.4	84.2	80.9	86.2
Mean	13.8	15.7	15.7	47.9	47.9	48.9

Estimated based on CSLC-2016.

not allow tracing how the regional structure of computer literacy and Internet access changed during any long period of time. However, the changes can be indirectly assessed using the statistics on the percentage of households that own a home computer (submitted by Rosstat since 2010), which increased 1.4-fold, from 54.5 to 74.3 percent, in 2010–2016. The growth rates differ greatly across regions, being the highest in Ingushetia (13.3-fold), Karachay-Cherkessia (2.9-fold), Tambov Oblast (2.3-fold), Kostroma Oblast (2.2-fold), and Ivanovo Oblast (2-fold). High computerization of households in these regions is mostly explained by their low baseline rates. In Ingushetia, for instance, the percentage of households owning a home computer increased from 5.2 to 68.7 percent during the period of survey, yet the region has not even reached the country's average. Computerization rates below the average are observed in remote areas (0.9-fold in the Republic of Sakha, 1.1-fold in Kamchatka Krai, Sakhalin Oblast, Ud-

murtia, and Chuvashia) as well as in highly-computerized regions (e. g. 1.1-fold in Moscow). Consequently, not only computerization rates increased but they also became more equalized across the country. The coefficient of variation in the percentage of households with a home computer in the region decreased more than twice between 2010 and 2016 (from 0.26 to 0.12).

Conclusion

Comparison of ICT literacy across different types of social groups in Russia reveals the main factors of the digital divide and, consequently, the at-risk groups in which low ICT skills inhibit adaptation to the digital economy. At-risk population categories include older adults, low-educated people, low-income citizens, and rural dwellers. The regional factor adds to the digital divide. Risks are multiplied for the population groups affected by two or more negative factors, so targeted adaptation measures and programs should be developed to support them. Special attention should be paid to at-risk youths, as ICT illiteracy will inevitably become a major hindrance to their careers, making them unattractive for employers in the context of high Internet literacy among coeval competitors in the labor market.

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