Chapter 6
Information and Communication Technologies in Russian Education: Background and Outlook

Diana O. Koroleva

Abstract This chapter takes historical and forward-looking perspectives on the implementation of information and communication technologies (ICT) across the Russian educational landscape. We first discuss how Russian public policy with respect to ICT-supported education has been transforming over time, while briefly addressing the principal phases of this ongoing digital move as reflected in evolving ICT perceptions and development priorities, deployment approaches, as well as key outcomes, challenges and further action plans. Next, we explore how the present-day digital agenda for future-proof education is being conceptualized and implemented in practice by taking insights into the following individual areas: 1. ICT Infrastructure; 2. ICT Learning Resources; 3. ICT in Instructional Practice; 4. Student ICT Competence; 5. Teacher ICT Competence and Upskilling. The final sections give a round-up of findings with respect to the current status and outlook for ICT development in Russian education. This paper is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics, Moscow, Russia.

Keywords ICT in education · Russian case · The third wave of informatization · Digital economy

6.1 The Russian Education System: Brief Overview

The core piece of legislation governing the Russian education system is Federal Law "On Education in the Russian Federation" (2012). According to this law, until May 2018 the executive body in charge of the formulation and implementation of education policies at all levels was the Ministry of Education and Science of the Russian Federation. In 2018 executive the body was split in two: the Ministry of

D. O. Koroleva (✉)
Centre for the Study of Educational Innovations, Institute of Education, National Research University Higher School of Economics, Potapovsky pereulok 16/10, Office 307, 101000 Moscow, Russia
e-mail: koroleva_dia@mail.ru

C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_6

Education, responsible for primary and secondary education, and the Ministry for Science and Higher Education.

The Russian system of general education consists of preschool, elementary and secondary stages. It normally takes 11 years to obtain a certificate of complete secondary general education. Vocational education and training in Russia is available at both the secondary (basic vocational training) and post-secondary (specialist college degree) levels. Those seeking to pursue tertiary (higher) education can receive training in Bachelor's and Master's university tracks. According to the Russian Federal State Statistics Service, in the 2015/16 academic year the Russian education system enrolled a total of 14.8 million schoolers and another 4.7 million university students.

In recent years, Russian education policy has primarily emphasized the following as its systems imperatives: enhancing diversity and accessibility in preschooling; improving the quality of educational outcomes at different levels; advancing opportunities for continuing learning and development; and reinforcing the nation's uniform and high-standard educational space.

- Workforce for Advanced-Technology Occupations.
- Universities as Linchpins of Sustainable Innovation Ecosystems.
- Modern Digital Learning Environment in Russia.
- Modern Educational Environment in Schools.
- Accessible Children's Extracurriculars.
- Fostering Russia's Potential for EdTech Exports.

All of the above-listed projects imply, to a greater or lesser extent, further developing and harnessing information and communication technologies (ICT) in education as an important component of their respective agendas. Below we provide a detailed discussion of how ICT-related objectives of Russian educational policy have been transforming over time amidst the changing role and scope of ICT in the economy and society.

6.2 ICT Implementation in Russia: Historical Outline

Since the mid-1980s, Russia has seen a vast number of policy initiatives aimed at fostering various aspects of ICT integration into national learning environments. The first wave of education informatization went underway in 1980s, when Decree No. 13-XI "On the Reform of General and Vocational Education" was passed in April 1984. As a result of this policy step, Russian schools and universities were equipped with the essential computer infrastructure enabling access to basic ICT. In terms of the curriculum, a new course, "Computer Science," was introduced in secondary schools, and some STEM (Science, Technology, Engineering and Mathematics) teachers received special training in IT and computer operation to be able to give appropriate instruction in this new subject. Also, some training in computer basics was organized for teachers in other subject areas as well as for school administrators. At the same time, a number of disincentives and downside factors of various scale and socioeconomic nature dampened this reformative momentum. For one, there was a huge gap between urban and rural schools in Russia; for another, educators themselves would often counter the reform and the ICT transitioning processes it had prompted amidst then meagre awareness of the new role that ICT was soon to obtain as a major competitive driver in technology and human capital. The fall of the Soviet Union embroiled Russia into a situation of persisting socioeconomic disarray where education-related objectives long remained outside the state executives' top-priority agendas. It was not until the late 1990s that education informatization came back to broad public and government attention.

The second wave of education informatization, which spanned a period from the late 1990s and through 2010, was marked by a surge in the number of initiatives to facilitate ICT-supported learning at both federal and various regional levels. These were complemented by a series of non-government endeavours run by international foundations and other organizations, such as World Bank, Intel and Microsoft, among others. For educators, training & development programs were deployed that sought to advance ICT literacy within a broader multidisciplinary cohort of instructors, unlike in the first wave of informatization when only limited teacher corps received such IT-focused professional upskilling. The above-mentioned measures to boost ICT integration into the educational perimeter have yielded noticeable enhancements in the overall ICT infrastructure. Thus, schools have been procured with more comprehensive background hardware, including computers and related IT systems, laptops, e-boards and other multimedia, which has facilitated the creation of mobile classrooms, hybrid libraries and media centers with access to various electronic learning resources, etc. In higher education, a number of massive state-run programs have also been implemented to spur sector digitization and ICT-assisted networking for more effective administrative and academic operation. Taking stock of the said period, as noted in the OECD's "Measuring Innovation in Education" report, Russia has achieved a major progress in transitioning to a digitally supported educational model thanks to the improved availability of computer and internet infrastructure across the country's institutional landscapes (OECD, 2014).

Today, implementing ICT in education remains among the chief imperatives of Russian educational policy. While it is barely possible to identify any predominant focus area or key development program in the field, a host of initiatives aimed at modernizing education through further integrating the use of ICT are currently underway at both the county-wide and local levels.

6.3 Current ICT Policy Framework in Education

It is the Federal State Educational Standard [Federalny Gosudarstvenny Obrazovatelny Standart, FGOS], which is adopted in Russia for each individual level of education, that provides a fundamental framework regulating such facets of schooling as the curriculum requirements, the most appropriate instructional models to be used, as well as the learning outcomes expected at each stage of the educational ladder. Insofar as ICT is concerned, FGOS emphasizes the need to develop the entire range of student ICT competencies as an important part in delivering on such broader aims of EdTech innovation, as spurring student motivation, including to build a sustained capacity for self-propelled learning, to facilitate syllabus progression and knowledge acquisition, and hence to improve the overall quality of education.

According to FGOS, metasubject learning results in elementary school (1st–4th-graders aged 7–10 years) include active use of speech and ICT means for solving communicative and cognitive problems. In lower-secondary schooling (grades 5–9, teens of 11–15 years), FGOS sets out the formation and development of comprehensive basic ICT competency as the expected metasubject outcome. For upper-secondary education (high school grades 10–11, 16–17 year-olds), FGOS envisages the ability to use ICT tools in solving cognitive, communicative and organizational tasks as the key competency to be acquired. According to the educational standard, a high schooler is also expected to become well-versed in a fairly broad range of specific Computer Science areas, including the basics of network architecture and operation, the essentials of information ethics and law, cybersecurity and safe ICT practices, etc.

In higher education, there is no uniform FGOS, as separate standards exist for individual groups of majors. Nevertheless, each such standard has a provision regarding the ICT knowledge and skills students enrolled in a given higher education track are expected to possess. On aggregate, the following is outlined as a generic ICT competency profile of a university graduate: using ICT skills in a variety of social, learning and professional contexts, including necessary hardware, software and network means; using database solutions and other ICT in effectively handling various job tasks; broad software, web technology and digital networking literacy, etc.

An important criticism of the Federal State Educational Standard is its framework nature. Since FGOS lacks any clearly articulated principles or mechanisms whereby the stated metasubject competencies and individual learning results should be best attained, it needs to be complemented by more elaborate and definitive legislation pieces by individual level of schooling to become a more effective regulatory means.

As has been stated above, further developing ICT-supported education at all levels has been among the lasting priorities on the Russian government's social policy agenda, and a series of state-propelled initiatives aimed at effectively addressing these education digitization goals have been underway. Of the entire multiplicity of such innovative endeavors, which are being carried out in both federal and regional educational jurisdictions, several ones where the greatest resource is involved and high-impact payoffs are expected are worth a close-up consideration.

In a national and global setting of drastic societal change, where learning & development is becoming an increasingly lifelong imperative, the first such project, "Modern Digital Learning Environment in Russia," aims to create a uniform and high-standard electronic educational space that would reach to the widest and the most diverse cohorts of Russian population. The project scope involves creating the basic development conditions for this mass-accessible e-learning environment by

2018. In a longer run through 2025, the participation of Russian learners at all levels in various online courses is conjectured to reach 11 million people thanks to this national digital learning space initiative.

Another initiative to be noted is the "Moscow e-School" project, which has been a joint endeavor between the Russian Education and Science Ministry and the Government of Moscow. According to its official web page,[1] this e-schooling platform allows teachers to draft electronic lesson plans and scenarios, to create virtual labs and implement other content formats that can be effectively harnessed in classroom as a variety of ICT-assisted teacher–learner interactions involving such modern e-media as smartboards, personal tablets, smartphones, etc. Upon expert verification, the most practical and expedient developments will be identified within the entire pool of uploads, to be subsequently digitized and made available for e-circulation, further improvement, etc. Overall, this project envisages accumulating and sharing a comprehensive electronic lesson plan and learning aid repository as its bedrock idea. Thus, with time, teachers outside Moscow will be able to access such best-practice developments by their Moscow peers, while regional schoolers will take advantage of a multitude of handy digital resources, including core syllabus materials and extra aids, interim and exam tests, etc. Importantly, "Moscow e-School" will serve to promote innovative, result-driven teacher practices and learning formats, such as instructor networking on foremost ICT-supported pedagogical design models, collaborative learning, etc. Alongside its current focus on generating a pool of adequate academic content, the project also entails massive state-funded infrastructural procurement (modern IT systems, portable equipment, smart interaction devices, etc.), which is already fully underway. In a sense, this systemic implementation approach sets the "Moscow e-School" initiative apart from many similar endeavors (i.e., subsequent to 2010). In comparison with that period when objectives of education digitization have typically seen some blurring and little state-level support has normally been provided for infrastructural upgrades "Moscow e-School" has clear goals and tools to achieve them.

Going forward, it is the newly adopted "The program Digital Economy of the Russian Federation" (2017) that is most likely to lay the essential groundwork for shaping much of Russia's policy with respect to further fostering ICT in education. Seeking to nurture an environment for systemic development and deployment of digital innovation across the realms of social and economic living, the program envisages policy updates addressing the following five key areas: education, human capital, research, IT infrastructure, and cybersecurity. Given how ambitious the program's scope and objectives are, as well as judging by its elaborate implementation roadmap, one can reasonably anticipate a massive turnaround in the national ICT-related educational policy to commence in the near future.

[1] https://www.mos.ru/en/news/item/29343073/.

6.4 ICT Infrastructure

Statistical research on ICT accessibility in Russian schools (Zair-Bek, 2016) suggests there was one computer available on average per seven students in 2014, almost a tenfold improvement on what was recorded in 2001. Similarly, according to this report, 95.8% of Russian schools had stable internet connection in 2014, whereas the respective indicator was zero in 2001.

In recent years, many schools have been carrying out local programs to expand and renew their ICT infrastructure, which involve procuring modern desktop PCs, server and network equipment, as well as portable and tablet devices that have received growing popularity among an ever-expanding population band in today's settings of ubiquitous mobile communication and networking. These modernization initiatives are typically financed on a multilateral basis, including schools' own funds, parental donations and corporate sponsorship. Among the projects implemented on a state-subsidized basis, the "Moscow e-School" digital resource repository project can be noted (see above for a detailed description), where individual Moscow secondary schools have been receiving full-scale ICT infrastructure upgrades (see Table 6.1 for supply breakdown by type of fixed assets).

However, stark variances have been observed across Russian regions in terms of the development level of their ICT-supported educational infrastructure. In rural schools, for example, student coverage by computers with internet connection is still lower than in urban schools. Also, there are many regions where a significant proportion of schools have access to obsolete ICT only, because of highly antiquated computer equipment and allied infrastructure.

At the same time, according to the International Computer and Information Literacy Study (ICILS), the availability of school computers is a major positive factor in students' ICT literacy attainment (ICILS, 2013). Thus, ICILS has found that making active use of ICT means and resources in instructional practice adds an average 8.7 points to the student test score (the average score—516). By contrast, such limitations to ICT use as obsolete equipment, scarce technical support, lack of time spent on ICT-assisted study, etc. can lead to an average 8.5-point decrease in the student test score. Notably, Russia has demonstrated the strongest correlation between ICT availability at school and student ICT literacy gains among all of the ICILS participant nations.

When it comes to higher education, the ICT coverage patterns appear to be similar to what has been reported for secondary schools. Thus, according to the Russian

Table 6.1 "Moscow E-School" project: Planned and actual ICT equipment supplies

	Planned	Supplied (August 2017)
Laptops	38,917	4221
Servers	1840	219
Wi-Fi	59,016	5007
Interactive boards	20,331	2336

Federal State Statistics Service, there was one on-campus computer available on average per four university students in 2014. Barring the stock of PCs without permanent internet access, the average ICT coverage ratio in Russian universities is lower—one computer per five students.

While discussing the latest trends in today's ICT-driven educational environments, it is necessary to note the ever-expanding penetration of modern web, mobile and cloud computing technologies. These have become part and parcel of various learning settings, amidst the ongoing growth in the accessibility of smartphones, wearable communication devices, etc. among broader socioeconomic population groups, as the global mobile technology sector has thriven in recent years to offer an increasingly diverse product mix in different market segments. It is therefore no wonder that the youth, who are unfailingly the most active explorers and typically take a keenest interest in cutting-edge technology and equipment, are the major consumers of foremost ICT. Recent empirical scrutiny on the matter (Koroleva, 2016) provides compelling evidence for this argument. According to the study, 93% of Russian middle schoolers own and actively utilize smartphones for a broad array of communicative purposes. Alongside the out-of-school perimeter, which is traditionally the broadest realm where mobile devices are used by adolescents for peer communication and entertainment, the survey participants have also noted the increasingly prominent role of smartphones as mediators and facilitators in regular school life and learning, including classroom activities, group work, home assignments, etc., as well as in extracurricular and self-study practices. From the regulatory standpoint, however, mobile phones have not yet been officially recognized as an ICT educational technology in Russia, and there has yet to be an appropriate legal framework created that would formalize and govern the educational use of smartphones and other similar digital devices. So far though, whether to encourage or, by contrast, to limit or even completely ban the use of such technologies and devices in a learning & development setting is at the entire discretion of an individual educational entity.

6.5 ICT-Based Educational Resources

As the ever-hastening ICT move has sparked a universal transition to data-driven ecosystems, including digital business and world-spanning social networking, global data volumes have surged dramatically in recent years. According to McKinsey, between 2010 and 2015 international electronic data flows grew at a rate nearly 50 times as high as the average pace posted in the previous decade (McKinsey and Company 2017).

This data boom has also been true of the educational sector, which has seen the continuously expanding supply of both free and paid-subscription digital learning resources. Created by multiple educational stakeholders, e.g., teachers themselves, e-learning vendors, etc., such developments include a diversity of websites and mobile applications featuring educational games and other interactivities, multimedia content, hypertext documents, virtual labs, etc. Today, these resources cover almost all subject areas, and they are typically arranged in a way to offer convenient access to individual repositories organized by a given field of knowledge, level of schooling, skill level, etc.

It should be noted, though, that a major portion of such e-offerings are custom developments mostly reflecting individual teaching experiences and conceptions with respect to modern ICT-supported educational design. Importantly, much of this electronic content has never been subject to any expert validation to assess whether such offerings are actually appropriate and measure up to national and global educational requirements. Apart from these concerns about the academic adequacy of the featured content, the e-learning resources in question have also suffered a lack in technical consistency and the overall quality of implementation (e.g., poor sound and graphics, awkward and unintuitive interface, etc.). These factors have altogether pinpointed the need to address this market fragmentation through suitable law & policy.

To that end, a federal standard on educational ICT and electronic learning resources was adopted in Russia in 2011. While seeking to bring in more consistency by stipulating a set of general classification and organization requirements this educational domain should abide by, the standard has nevertheless failed to offer any well-defined, unambiguous framework conducive to a uniform development space of improved ICT resource quality and compatibility. As a result, the Russian market for ICT learning aids keeps evolving unsystematically amidst an overwhelming supply of arbitrary offerings. Accordingly, this environment of no clear-cut guidelines, when educators are left with the task of evaluating and selecting ICT aids by themselves, as best fit for their personal educational contexts, may be treated as a noticeable downside to the quality of national teaching practices and learning outcomes as a whole. Worth mentioning, however, the large-scale projects those appear on the market. Attention may be drawn to a number of examples:

Schools across the country are adopting United Learning Management Systems (LMS) Dnevnik.ru. It is the largest educational school management system project in Russia, connected to more than 6 million customers and 27,000 schools (more than half of all schools of the Russian Federation). It is significant that Dnevnik.ru represents a commercial product and Government had not participated in its elaboration. However, the Government introduced LMS onto the education market. This particular case could be considered as the effective public–private partnership.

Online learning space Znanika providing necessary tools and algorithms for students' assessment and competition. According to statistic Znanika has 1, 5 million users and 145 thousand registered teachers. It supports and caters to each teacher's unique blend of student-driven learning and teacher-led instruction. The application is used for students competitions (olympiads) mostly math and science and evaluation of the quality of education.

Ten applications of artificial intelligence in education becoming more and more popular. Online chatbots in particular, the most common case. The Russian language chatbot was created to improve communication skills and help foreign students learn Russian language. Mendeley is a chatbot to memorize the periodic table and learn the chemical elements. Both services were presented at the National Education Innovation Competition (KIVO)[2]—a joint project between Institute of education HSE and the Rybakov Fund that aims to support grassroots innovations in learning & development.

When discussing the key processes that have in recent years been framing the Russian learning & development landscape, another important ICT milestone should be stressed, i.e., the advent of Massive Open Online Courses (MOOC). In 2015, following the Council for Open Education was established in late 2014 at the initiative of the Russian Education and Science Ministry, eight leading Russian universities[3] set out to create the National Open Education Platform (NOEP). Along with representatives of these universities, officials with Russia's Federal Service for Education and Science Supervision and Education and Science Ministry joined the Council. For purposes of NOEP development and operation, a Project Association was then established in April 2015 by the above participant institutions.

The NOEP project, which aims to implement a comprehensive, internationally competitive Russia-based e-learning platform, pursues a broad and diversified agenda, where the following essential objectives can be singled out:

- Publishing online courses created by members of the Association.
- Monitoring global best practice and facilitating the adoption of international standards in this educational domain.
- Formulating and advancing quality standards for online courses.
- Collaborating with providers of higher educational programs; pursuing broader multi-stakeholder partnerships.

At the moment, the NOEP Project Association has expanded to comprise a total of 17 member universities, with its collaborative MOOC platform already offering more than 250 certified online courses. Notably, this initiative has also had a series of important policy and practice implications at various educational levels. Thus, for instance, introducing individual MOOCs as part of official coursework has received an increasingly wide following at Russia's institutions of vocational education and training (students can redeem their MOOC pass certificate to earn a credit for respective subject). In terms of ensuring quality training and due recognition of educational outcomes, Russia's NOEP venue has a fully-fledged functionality for building effective and representative individual e-learning paths. This includes, among others, secure student authentication; an advanced academic tracking & monitoring system, which renders a comprehensive snapshot of a learner's attempted and completed credits as well as evaluations and test scores received; opportunities for authorized third parties to engage in the learning process by supplying extra resources and aids, overseeing the evaluation process, etc.

[2]National Education Innovation Competition (KIVO) www.kivo.hse.ru.

[3]National Research University Higher School of Economics; National Research Nuclear University; Ural Federal University; Lomonosov Moscow State University; National University of Science and Technology; National Research University Saint Petersburg State University of Information Technologies, Mechanics and Optics; Saint Petersburg University; and St. Petersburg Polytechnic University.

6.6 ICT in Teaching Practice

According to an international study by OECD, Russia ranks among the world's top five economies that recorded the highest pace of innovation in their national systems of secondary schooling between 1999 and 2011 (OECD, 2014). The list of nine areas of innovative education development the study was focused on includes such ICT aspects as the growth in computer penetration and internet access across school environments. It can therefore be inferred from what the OECD ranking suggests that various policies and measures the Russian state authorities have been implementing to support ICT integration into the educational perimeter since the mid-1980s have fully or partially achieved their objectives.

At the same time, it should be stressed that the latest surge in ICT, spurred by the ever-intensifying streams of transdisciplinary innovation, has fueled a digital transition as grand and ubiquitous as never before. Astounding advances in micro-computing as well as mobile and web technologies have prompted a dramatic expansion in data systems and digital communication infrastructure between 2010 and 2015. The rise of digital networking, where ICT have become central to virtually every facet of doing business and social interaction as a whole, has pushed the upcoming ICT agenda in education far beyond maintaining technical competitiveness proper. If learning environments are poised to succeed in accommodating this digital momentum depends increasingly on how well the human capital at stake is prepared to respond to this universal call for going digital, and namely on whether educators will take a more proactive part in forging learning & development practices better aligned with digitally-driven imperatives of broader socio-economic strategies.

To sum up, if the technical infrastructure available at an educational organization is sufficient and up-to-date, and whether the organization's administrators and teaching staff are positively disposed to modern information and communication technologies are the two pivotal forces determining the extent and pace of transitioning to the new paradigm of ICT-supported learning.

Analyzing the Russian educational space in terms of the above factors of infrastructural adequacy and teacher sentiment toward ICT suggests a situation where the processes of ICT integration into instructional frameworks may be described as still largely arbitrary and fragmented. Notably, this inconsistent and irregular nature of ICT integration patterns, which are basically not matched with any cohesive action plan, has been observed both at the cross-regional, regional and individual institutional levels. These observations have also been confirmed by evidence drawn through a series of interviews[4] with public school principals on how they assessed the achievements, perils and shortcomings in transitioning to ICT-supported educational practices, insofar as the said facets of the available technical infrastructure and teacher ICT motivation are concerned.

[4]The sample included 15 principals (10 women and five men; mean age = 47) from the Russian cities of Moscow, Saint Petersburg, Vladivostok, Chelyabinsk, Yekaterinburg, Samara, Kaliningrad, and Voronezh. The interviews were conducted in October 2016.

Infrastructural downsides consist in the fact that the Russian educational system is still substantially underequipped, or lacks industry-standard equipment, to hold up to modern requirements for ICT. These technical resource gaps have not yet been adequately closed at both the national and individual community levels. Thus, as has already been noted, ICT accessibility ratios in rural schools have lagged way behind what is recorded in urban institutions. Furthermore, major variances in ICT availability have been observed between educational organizations operating in the same region:

> "Our school received some equipment as part of the "Education" national project [wound up in 2006], actually quite a while ago by now. We got the biology, history and geography classrooms reequipped – and that's it. As of today, the PCs in our IT classroom are completely antiquated." Principal at a public school in Samara (city with a population of 0.8 million people).

> "We've got interactive boards, document cameras, a new projector and, of course, computers. But as a leader I feel the need for new technologies and opportunities to be exploited in a more effective manner. So, my dream is to acquire an electronic flip chart, which would enable working with 150 students through mobile devices. It is really important for us to have an interactive wall, as we've got 1500 students and we're lacking space since our building just wasn't designed to house so many children." Principal at a public school in Chelyabinsk (city with a population of 1.2 million people).

Similarly, it should be admitted that strong headwinds have this far been confronting the Russian educational system when it comes to the second facet, i.e., the teacher's motivation and willingness to go digital and to better align their strategies with ICT choices and expectations of modern learners. While the Russian Federal State Educational Standards emphasize the active use of digitally assisted teaching techniques as a key component in nurturing adequate ICT literacy and skills with students at various training levels, the existing institutional landscape is often unresponsive or literally resistant to this important imperative. It turns out that achieving a more sizeable and uniform progress in harnessing ICT-supported instructional best practices is hindered by the operational environment of patchy institutional policies & procedures where decision-making on whether to go digital, and to encourage others to do so, virtually remains at arbitrary discretion of individual administrators and teachers themselves:

> "Things have been pretty fine in terms of equipment, but teachers' willingness and choice of information resources are crucial. It's not about the absence, for example, of a device, it is actually not a problem at all. We can apply for a funding award to get it procured, to ask parents for a financial hand after all, but it all just doesn't work unless the teacher is willing to engage. Just as an example, we've got a mobile classroom equipped with laptops, but they're barely ever used at all. At the same time, there are smart boards up in every room, and using them to add vividness and interactivity to daily classroom activity has become an increasingly widespread practice." Principal at a public school in Yekaterinburg (city with a population of 1.5 million people).

It should be noted that the above description only provides a high-level portrayal of the general state of affairs insofar as adopting modern ICT means in Russian education is concerned, with no distinction drawn, for example, between non-specialist vs. specialist IT curriculum (the latter, which includes various tracks in programming and other specific IT areas, is subject to well-defined and comprehensive ICT requirements).

6.7 Student ICT Competence

According to the ICILS international study of 2013, Russia holds the sixth to eighth place by schoolchildren's ICT literacy together with Germany and Slovakia. With an average ICILS score of 516, Russian schoolers performed substantially below their same-age peers from Czech Republic, Australia, Poland, Norway and South Korea, but were superior to students from Croatia, Slovenia, Lithuania, Chile, Thailand and Turkey.

When the Russian sample is analyzed in terms of individual test results, the following can be observed (see Fig. 6.1). Almost every tenth student (9%) failed to achieve the ICT Level One (i.e., basic literacy) score. The proportion of those scoring at the ICT Level One and ICT Level Two was 27 and 41%, respectively. Finally, a little more than a fifth (21%) of all Russian schoolers who took up the test made it into the ICT Level Three band. Notably, girls have scored on average 13 points higher than boys on the ICILS.

The ICILS framework shows that ICT literacy has a strong correlation with the socio-demographic factor, i.e., whether students come from an urban or rural area and how populous their place of residence is. Thus, in locations with a population of under 3000 people (mostly the countryside), about 60% of Russian eighth graders were, at their best, capable of solving basic ICT Level One tasks only (see Fig. 6.2). In major urban areas with a population of one million people and above, a much higher proportion of eighth-grade students have passed the ICT Level Two and ICT Level Three test assignments. At the same time, it should be noted that the share of

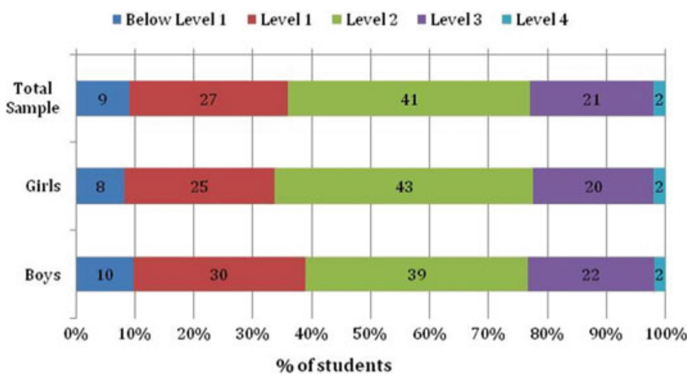

Fig. 6.1 Russian students' scores by ICT literacy level and gender, ICILS 2013

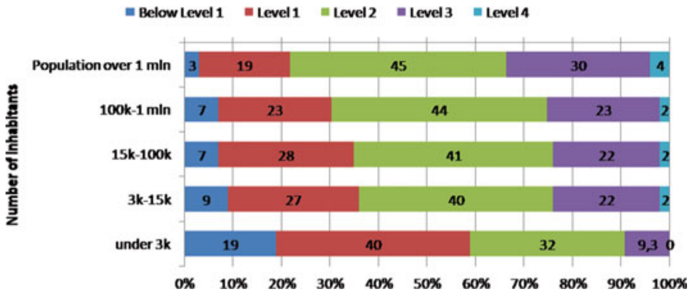

Fig. 6.2 **Russian** students' scores by place of residence, ICILS 2013

those who scored at the ICT Level Four, which is the most complex tasks requiring advanced ICT skills, was universally insignificant for the entire sample.

Another evaluation framework, the Information and Communication Literacy Test, which eighth to tenth graders in various Russian regions took up during 2012–2016, further attests to a situation where stark gaps in ICT literacy between urban and rural schoolers have been observed, with a particularly high share of countryside children who barely have even a basic or elementary level of ICT skills. What is alarming, the study claims, is that no effective remedies have so far been coined in Russia to effectively bridge this gap, so the skill lag between the city and less socioeconomically advantaged rural territories is arguably set to expand further.

It should be noted that there is only limited data available to judge about the ICT literacy of Russian higher education students. Thus, for example, a cohort of young Russian adults between 16 and 24 years of age, who participated in the Program for the International Assessment of Adult Competencies (PIAAC) of [2013], have been reported to earn an average score of 283 on a set of assignments aimed at evaluating the ability to use various ICT for obtaining information and solving practical problems in a technologically saturated environment (Nellemann, Podolskiy, & Levin, 2015). This PIAAC score translates into a Level One information and communication technology competence for adults (for reference, the average OECD score is 295).

Importantly, the same average score (283) was recorded for both a younger cohort of pre-laborers aged 16–19 years as well as a senior group of participants between 20 and 24 years of age. Alongside the fact that the Russian youth are generally inferior to their international peers in terms of ICT competences, this situation may also be suggesting that very little or even no ICT skill addition takes place during the most dynamic and prolific cognitive life stage of young adulthood. Given that educational attainment is generally recognized to progressively taper with age, and considering today's ever-expanding ICT skill requirements in the job market as a reflection of an accelerating transition to digitally assisted non-routine labor, this ICT competence gap may present a considerable challenge to workforce efficiency.

6.8 Teacher ICT Competence and Professional Development

According to the Teaching and Learning International Survey (TALIS), middle-aged people of 30–49 years old made up nearly half (48%) of Russia's total schoolteacher corps in 2013 (Pinskaya et al, 2015). Those falling within the pre-retirement and retirement age group of 50–59 years accounted for another 30%. Finally, about a tenth of all secondary teachers were found to be still in profession while in their sixties.

In the cohort of young teaching professionals, the following important trends can be observed. The proportion of teachers under 30 years of age was reported at 12.3% for Russia, which is close to the survey's all-country average. This indicator remained largely flat over the five-year period since the previous 2009 TALIS survey (11%). Notably, the share of secondary teachers aged under 25 was almost twice as high in Russia as compared to the average value for all the participant nations.

The above statistical outline shows that as far as the workforce age structure is concerned, the Russian educational sector has over the past several years been influenced by the following two counter factors. For one, the average instructor cohort has been getting younger reflecting the growing attractiveness of the teaching profession in Russia. At the same time, this trend toward teacher corps renewal has been moderated by a significant proportion of senior-age staff choosing to continue their service in an economic environment where major gaps between the salary level and the average retirement allowance have not yet been closed.

The 2013 Russian Professional Standard for Teachers has a large number of provisions with respect to the ICT competences and skills that an instructor should possess. According to the Standard, the key competences are as follows:

- General user ICT competence.
- General teaching ICT competence.
- Specialist teaching ICT competence, which is the ICT proficiency in one's individual area or areas of training expertise (based on recommendations of UNESCO ICT Competency Framework for Teachers, 2011).

The Russian education policy in place requires that teachers upgrade their skills and competences on an ongoing basis by enrolling in professional development programs at least once in three years. Modern upskilling tracks for educators involve ICT training as one of the key components on their curriculum, which covers such areas of proficiency as, for example, interactive and multimedia classroom equipment; web technology and mobile devices; e-courseware and digital learning design; etc. Today, teacher development programs offer plenty of educational choice and flexibility in course progression thanks to a diverse mix of delivery formats available in the marketplace, e.g.:

- Courses at specialized learning & development centers.
- Off-job tracks.

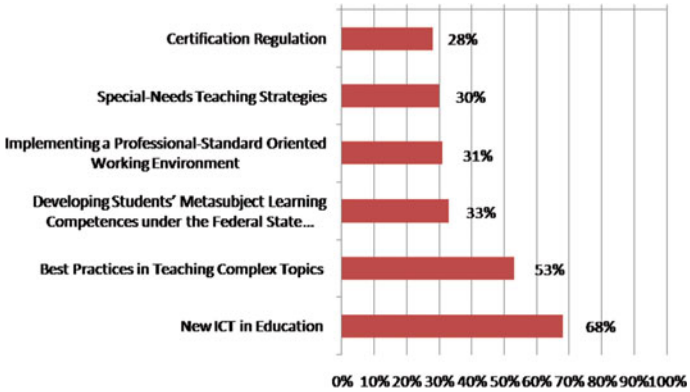

Fig. 6.3 The most sought-after teacher development courses in Russia

- Certificate online courses.
- Hybrid learning offerings.

Statistics published on the "Netologia" educational website[5] suggest there are currently more than a million active schoolteachers in Russia, of whom about 350 thousand annually engage in various professional development opportunities. Among training courses that have in recent years enrolled the largest proportion of Russian teachers are: New ICT in Education (68%); Best Practices in Teaching Complex Topics (53%); Developing Students' Metasubject Learning Competences under the Federal State Educational Standards (33%); Implementing a Professional-Standard Oriented Working Environment (31%); etc. (see Fig. 6.3).

A major downside that can be noted when discussing teacher professional development in Russia consists in the fact that only less than a half (42%) of all educators who sign up for training manage to complete their coursework (20% quit after the first lesson, and 38% do not even reach the middle). Furthermore, 6.5% of those who are allowed to take the final examination ultimately fail scoring substantially below the established passing threshold.

This situation where a substantial mismatch has existed between the amount of continuing learning & development formally attempted by the national teacher corps and the net payoff these endeavors generate may be largely attributed to the employed Russians' overall negative sentiment to professional upskilling and poor intrinsic motivation for lifelong learning as a whole. Thus, according to a 2013 survey by the Public Opinion Foundation, about 40% of working Russians have reported they are unlikely to engage in any professional development opportunities in future. Another 40% of the respondents, who have been found to be more likely to enroll in extra training, have voiced securing a promotion or getting a pay-rise as the key considerations for seeking skill upgrades.

[5]https://netology.ru.

6.9 Outcomes and Achievements

It can be inferred from what has been discussed earlier that ICT have taken a long and largely uneven development course to become part and parcel of the Russian educational landscape. The process of implementing novelty ICT means and instructional practices has seen several major waves where the Russian state at different times pursued different objectives and practical roadmaps for getting the former accomplished. Alongside a broader context of the dramatic and dashing change that Russia underwent as it moved from command administration to the quasi-market and market political and economic paradigm, these policy variations have also reflected, more specifically, how overall conceptions and expectations with respect to ICT, and namely regarding their prospective role in carving out future societal pathways, have been evolving over time. Thus, the following key stages of ICT implementation in Russian education can be revisited in concluding our discussion.

The first phase of the digital move, which spanned a period of the late Soviet era of the mid-1980s and through the turnaround time of the 1990s, was marked by the principal focus placed on establishing the pivotal IT asset base across the national educational perimeter. This period saw the mass-equipping of Russian schools and higher educational institutions with personal computers, which at that time mostly served as a means to tackle a series of standardized, basic computational and modelling STEM tasks, including through mastering and applying the essentials of computer programming. ICT penetration at that very stage was almost entirely limited to the framework of the newly established Computer Science subject. Delivering instruction in Computer Science was primarily entrusted with the math teacher corps, who would typically receive prior basic IT training. It should be noted that, while the ICT scope was concentrated within a single syllabus area, introducing these information technology fundamentals has heralded an important innovative impetus for schooling as students were getting actively engaged in mastering the new cognitive and technical domains of algorithmic thinking, programming and other basic elements of human–machine interaction. (Notably, this subject area then piqued a most pronounced and vivid interest among the youth because the Computer Science classroom long remained virtually the only option left for students to become familiar with the enthralling realm of IT.)

What followed during the era of 1990–2000s has seen information and communication technologies gradually span the whole learning & development domain by penetrating into and transforming both the very substance of education and the entire multiplicity of instructional models and aids. Back into that time, the accelerating processes of ICT-supported learning innovation came to embrace a progressively broad cohort of instructional staff across training areas, whereby the ICT transition gained a robust pace to leap way beyond Computer Science proper. As a brand-new class of electronic learning resources has come on-stream, the computer and information technology as a whole have evolved into an inalienable systemic part of the interdisciplinary curriculum and regular learning practice, which has enabled a host of novelty models of communicative and cognitive interactions facilitating, among others:

- Active self-study and the overall capacity for self-directed learning.
- Changes in the teacher's role toward more learner-centered and personalized strategies.
- Transition to the new, and more collaborative, teacher–learner framework.

As we move on to the contemporary stage of Russian education, we can note that the public policy framework in place almost universally views ensuring the all-round development of global-standard student ICT competences, through effectively harnessing the entire multitude of modern ICT instructional aids, as among its paramount imperatives on the present-day agenda for sustainability and growth. That said, the overall state of affairs that has over the past several years been observed in practice is somewhat not fully matched with what national policies have purported. The extent and pace of how various ICT means have been entering the learning & development landscape can be plausibly described as patchy and inconsistent, with stark disparities well noticeable from both the cross-regional, regional and institutional perspective. The key downside to more streamlined and uniform adoption of modern educational ICT can be analyzed into such components as:

- Inadequate technical infrastructure in individual organizations and localities (slow internet connection, obsolete PCs, scarce availability of portable and multimedia teaching means, etc.)
- Lack of individual teacher motivation to go digital, which, in turn, precludes more appreciable peer effects.
- Arbitrary internal policies & procedures, which fail to provide a cohesive and unambiguous action plan that everyone would abide by.

Insofar as stakeholder expectations for today's uneven ICT implementation curve to be rectified are concerned, a great deal of promise is now attributed to the newly adopted "Program for Development of Digital Economy in the Russian Federation" (2017). The Program's massive scope and ambitious objectives, as well as how scrupulously its deployment roadmap is designed, all suggest we can reasonably anticipate a new large-scale upside effect on educational ICT to occur in the near-to-middle run, once this landmark initiative kicks into a higher gear.

6.10 Challenges and Strategies

As the globe-spanning digital move has been well underway (and is definitely poised to gain further momentum), various domains of social and economic life have seen deep and accelerating changes taking place across their ICT landscapes. The progressive advent of cutting-edge internet and computing technologies has prompted a surge in data volumes and an expanding shift to remote interaction means, such as task-specific free web-based and mobile apps, social media, software-as-a-service (SaaS) solutions, smartphones, tablet PCs, etc. Largely framed by the above global-scale processes, the Russian ICT market has also thriven in recent years to make a growing number of high-impact digital innovations become accessible to an ever-broadening population cohort.

In and of itself, there is no longer anything new about students and educators both progressively switching to mobile technologies as a handy tool to best handle their personal day-to-day tasks of information search, communication, etc. What is new—and most challenging—is to obtain a representative portrayal of how competent modern teachers and learners are in effectively applying frontline ICT means and techniques in the educational context. What makes this assessment task so important is the fact that as borderlines between the school and the out-of-school realms have been rapidly blurring these days, amidst the increasingly pronounced call for ubiquitous, collaborative and life-time learning, ensuring educational settings become truly empowering requires that both instructors and students possess comprehensive ICT awareness and savvy to cooperate in a prolific digital learning environment of shared goals, methods and outcomes. So far though, there has been little reliable evidence available to plausible gauge what the actual state of affairs with ICT-related teacher and learner competences is, namely because most of Russian and international research on the matter has still focused largely on the ICT educational infrastructure and skills existent as far back as the early-to-mid-2000s.

To reiterate, the digital landscapes have since then undergone massive and diverse changes across societal realms, including education. Modern learning & development settings have been increasingly absorbing the entire multitude of daily ICT practices. This expanding trend toward the real and the virtual worlds becoming more mutually penetrating and determinant with respect to one another has driven a turnaround in the substance and process of education, where much of conventional instruction has become obsolete given the new socio-communicative reality (e.g., single-faceted standardized teacher–learner interactions based on the Q&A format, etc.). Furthermore, as the ongoing globalization and digitization have been actively revolutionizing production and consumption models, a drastic reframing has also taken place in the job market, with the key emphasis now put on ICT-assisted non-routine labor. Accordingly, information technology and advanced communication literacies have come to top the entire 21st-century skills agenda, as being among the pivotal learnability and productivity attributers of future-proof talent.

It turns out that the Russian education systems is now confronted with a series of challenges and high-scope questions as to how the country's further ICT and educational development strategies can be best aligned to produce sustainable synergistic effects on social cohesion and economic growth. When addressing this top-priority task, it is first of all important to clearly assess (1) the overall framework and potential of harnessing modern ICT in facilitating the effective achievement of immediate and prospective educational objectives; and (2) the conditions under which this ICT potential can be unleashed at its fullest.

A series of practical steps that may be reasonably considered to be taken as implementing the above-described latest agenda in ICT-supported learning innovation gets underway include:

- Broadening the range of ICT means harnessed in the educational perimeter.
- Transitioning from mastering standard, basic-skill office apps to learning systemically about modern advanced ICT architecture.
- Further expanding and deepening the use of various ICT means and techniques within individual training areas.

We are confident that carrying out these measures will form important groundwork in securing a turnaround toward streamlined advancement into the third wave of digital transition.

Acknowledgements I want to express my gratitude to Igor Manokhin (HSE) whose proofreading and editing greatly helped the readability of my work. This work/article is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics (HSE University).

References

Fraillon, J., Schulz, W., Friedman, T., Ainley, J., & Gebhardt, E. (2015). (Eds.). *ICILS 2013 technical report.* (IEA).

Koroleva, D. (2016). Always online: Using mobile technology and social media at home and at school by modern teenagers. *Educational Studies*, *1*, 205–224.

McKinsey & Company. (2017). *Quarterly 2017 Number 2*, Published by McKinsey & Company, New York, P 122.

Nellemann, S., Podolskiy, O., & Levin, V. (2015). *State of adult education in Russia: ensuring that older workers can acquire the skills for of the future.* Washington, DC: The World Bank.

OECD. (2014). *Measuring innovation in education: A new perspective.* Educational Research and Innovation: OECD Publishing.

On education in the Russian Federation, Federal Law, December 29, 2012 № 273-FZ.

On the Reform of General and Vocational Education, Decree, April 1984, № 13-XI.

Pinskaya, M. A., Lenskaya, E. A., Ponomareva, A. A., Brun, I. V., Kosaretsky, S. G., & Savelyeva, M. B. (2015). What did we learn about our teachers and schools principals? The results of the international comparative study TALIS-2013 Public education 6 34 47 (in Russian).

Russian Professional Standard for Teachers, Decree, October 2013, No. 544n

The program Digital Economy of the Russian Federation, Resolution, July 28, 2017, № 1632

Zair-Bek S.I, Belikov A.A, Plekhanov A.A. (2016). Russian schools: the information revolution. *Education Facts and Figures*, P. 25. (in Russian).

Diana O. Koroleva is a researcher at the National Research University Higher School of Economics, Institute of Education. She holds the position of Director of the National competition for Innovations in Education. Koroleva specialises in the implementation and diffusion of innovations in education. Her research interests are: modern technologies in education, especially use of ICT tecnologies such as mobile phones and social networks. Koroleva repeatedly was awarded an Russian Humanitarian Science Foundation grants.