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INTELLECTUAL AND TECHNOLOGICAL DEVELOPMENT OF THE REGIONS: CHALLENGES AND WAYS TO OVERCOME THEM

The article examines the issue of intellectual and technological development of Russia and its regions. It demonstrates that the growing number of employed people with higher education is not accompanied by a proportional increase in the technological level of the economy, because the function of higher education has changed. It is gradually turning into a tool for ensuring the general cultural level of the population. The article describes the main reasons for the poor conversion of the growth in the number of employees with higher education into the technological growth. The author substantiates the need to consider the aggregate of employees professionally engaged in science and technology as the persons ensuring the intellectual and technological development. I proposed to call them the creators of intelligent technology. The author provided his interpretation of the concept of "scientific education" which, in his opinion, cannot be reduced only to developing the creative abilities of individual, but comes as a real knowledge of existing causes and effects in the development of nature and society along with the ability to reevaluate them critically. The article demonstrated that scientific education is formed directly in the process of research activities and that the support for scientific education preserves the quest for research in the society. It identifies the negative trends in the development of science associated with significant reduction in the number of employees engaged in research and development, and withdrawal of Russian businesses from research activities. The author reached conclusion on the need to invest in science in order to generate such scientific and technological progress that would raise the civilized nature of society and improve labor productivity.

Keywords: intellectual and technological development, intellectualization of the public, scientific education, creators of intelligent technology, higher professional education

1. Introduction to the Problem

There is an impression that the intellectual and technological development of Russia and its regions proceeds in some distorted and incomprehensible way. The statistical data indicate that there is a rapid increase in the employed population with higher professional education. In 2015, every third employed person (in Moscow, almost every second one) had a higher education diploma. One would expect this high level of intellectualization of society to be supported by continuous and general technological ascent of the country both domestically and at the global level, but this did not happen. In 2015, Russia's share in the global exports of high-tech products was about 0.4 %[1], which is dozens of times lower that the shares of other industrialized developed countries.

This raises a number of important questions. For example, why the increase in the number of employees with higher professional education has no effect on improving the intellectual and technological development of Russia? Or are these two processes weakly interrelated? Or are they so independent that they do not affect each other? Or is the higher education in Russia not as "high", or is it not in the required sectors, or are we using it unskillfully, or there is probably no effective system of public consensus on the conversion of the mass scientific knowledge into the mass advanced technology, or are there some other, yet unknown reasons.

On the one hand, the intellectual and technological development of the country cannot proceed without increasing the intellectualization of the public that shapes the ability of people to skillfully use the intelligent technology; on the other hand, the higher number of employed people with higher professional education has no clear effect on the increase of intellectual and technological development of society.

The current contradictory situation in the area of intellectualization and technologization of Russia not only exacerbates the problem of accelerating the intellectual and technological development, but turns it from just a relevant issue into a vital challenge.

[1] O Strategii nauchno-tekhnologicheskogo razvitiya Rossiyskoy Federatsii [On the Strategy of Scientific and Technological Development of the Russian Federation]. Ukaz Prezidenta Rossiyskoy Federatsii ot 01.12.2016 g. № 642 [The Decree of the President of the Russian Federation No. 642 of December 1, 2016]. (In Russ).

To address the described problem, the author advanced a hypothesis that the acceleration of intellectual and technological development of Russia and its regions is ensured not so much by the overall increase in the number of employees with higher education, as by the expansion of investments in the intellectual activity of researchers.

In his book "Contours of the World Economy 1–2030 AD" (2007, Angus Maddison (19262010), the British historian of the economy, noted that "it is important to distinguish between the lead and follower countries to understand the dynamics of technological diffusion, and analyze the processes of catch-up and following behind. Lead countries are those whose economies operate nearest to the technological frontier. The 'follower' countries have a lower level of labor productivity (or GDP per capita)" [1, P. 469].

2. General Illustration of the Problem

In general, the problem of intellectual and technological development of Russia and its regions can be illustrated by demonstrating the absence of clear relationship between the higher number of employed people with higher professional education and improvement of technological level in the economy.

The official data show the active growth in the number of people with higher education employed in the Russian Federation. While, in 1992, every sixth person in the employed population (16.1 %) had a higher professional education, in 2015, it was already every third (33.0 %) employee in the country (Table 1). Among the people aged 24–29 years old, 409 out of 1000 had the higher education, or almost every second person[2]

Table 1

The dynamics of employed population of the Russian Federation with higher professional education (as % of the entire employed population), 1992, 2000, 2010, 2015

Indicator	1992	2000	2010	2015	Growth, 2015 compared to 1992
Total	16.1	21.6	29.1	33.0	2.05 times
Men	15.0	19.8	25.9	28.9	1.93 times
Women	17.4	23.7	32.5	37.2	2.14 times

Compiled and calculated by using Russian Statistical Yearbook. 2003: Statistical Book. (2003). State Statistics Committee of the Russian Federation Moscow, 705 p. P.141; Russian Statistical Yearbook. 2016. Statistical Book (2016). Rosstat. Moscow, 725 p., P. 113.

For a more clear contrast, let us remember that, according to the General Census of Russia held in 1897, the number of "illiterate" in the country was 101 million people, or 78,8 % of the total population which, at that time, was 128.2 million people. Only 21.2 % of the population or 27.2 million people knew how to read and write. Among them, 26 million were people with lower school education. 1.44 million people, or 1.1 % of the total population had secondary and higher education [2, P. 433]. As for the higher education, in 1914, there were only 10 students per 10 thousand people in Russia, because the country had only 72 educational institutions of higher learning with 86.5 thousand students. In 2015, Russia had 896 universities with 4 million 766.5 thousand students. There were 325 students per 10 people[3].

It is worth noting that the main contribution to the number of employees with higher education is made by women. In 2015, their share (37.2 %) exceeded the number of men with tertiary education (28.9 %) by 1.29 times. But if we turn to the first General Census of the Russian Empire in 1897, we can see that, in this period, the literacy rate of men (29.3 %) was higher than the literacy rate for women (13.1 %) by 2.24 times[4]. The number of women among the students of higher learning was also insignificant. In 1895, just 2 thousand women were attending the Higher Women's Courses and other general education institutions for women. By 1914, their number increased to 33.8 thousand

[2] Rossiyskiy statisticheskiy ezhegodnik. 2016. Stat. sb. [Russian Statistical Yearbook. 2016: Statistical Book]. (2016). Rosstat. Moscow, 185. (In Russ.)

[3] Regiony Rossii. Sotsial'no-ekonomicheskie pokazateli. 2003. Stat. sb. [Regions of Russia: Socio-Economic Indicators. 2003. Statistical Book]. (2003). Goskomstat Rossii [State Statistics Committee of the Russian Federation Moscow]. Moscow, 203.

[4] Pervaya vseobshchaya perepis naseleniya Rossiyskoy imperii 1897 goda [The First General Census of the Russian Empire, 1897]. (1897–1905). In: N.A. Troynitsky (Ed.). Publishing House of the Central. Statistical Committee of the Ministry of Internal. St. Petersburg. (In Russ.)

people, or by almost 17 times[5]. A small number of women was studying in the universities. It would be interesting to study how the increase in the share and number of women with higher education affects the increase in the technological level of the economy.

It would seem that doubling the number of employees with higher education must necessarily be accompanied by increased amounts of intellectual products. However, this did not happen in practice. On the contrary, the scientific and technological backwardness of the country continues. In 2012, the share of Russia in the global exports of intellectual products was 0.22 %. At the same time, the share of China was 27.68 %, USA — 12.56 %, Germany — 9.58 %, South Korea — 5.75 %, Poland — 0.72 %, Slovakia — 0.59 % [3, pp. 160–161]. In addition, by 2015, Russia had more agreements on the import of technologies and technical services (2,986) than similar export agreements (2,236). In currency terms, the expenses on imports of technologies and technical services (2,205 million dollars) also exceeded the proceeds from their exports (1,655 million dollars). Moreover, in the analyzed period, the currency expenses increased by 3.85 times, i.e., from 5,72.5 million dollars in 2002 to 2,205 million dollars in 2015 (Table 2).

Table 2

Exports and imports of technologies and technical services in the Russian Federation

Indicator	Exports		2015 to 2002 (growth)	Imports		2015 to 2002 (growth)
	2002	2015		2002	2015	
Number of agreements, units	1,320	2,236	1.7 times	800	2,986	3.73 times
Cost of the subject matter of agreement, million USD	1,548.6	13,704.0	8.8 times	1,932.9	13,497.0	6.98 times
Annual proceeds, million USD	211.5	1,655.0	7.8 times			
Annual disbursements, million USD				572.5	2,205.0	3.85 times

Compiled and calculated by using Regions of Russia: Socio-Economic Indicators. 2003. Statistical Book (2003). State Statistics Committee of the Russian Federation Moscow, 8955 p., P.894; Russian Statistical Yearbook. 2016. Statistical Book (2016). Rosstat. Moscow, 725 p., P. 519.

Thus, despite a significant increase in the number of employees with higher education, the imports of technologies and technical services continued to exceed their exports both in terms of the number of agreements and in value terms.

Along with the "external" indicator of scientific and technological backwardness of the state, as demonstrated by the share in the global exports of intellectual products, an important "internal" measure of the intellectual and technological development of the country and its regions is the indicator of the innovative activity of organizations.

Table 3

The innovative activity of organizations in 2000, 2005, 2010, and 2015 (share of organizations engaged in technological, organizational, and marketing innovations in the total number of surveyed organizations, %)

Region	2000	2005	2010	2015
Russian Federation	8.8	9.7	9.5	9.3
Ural Federal District	10.6	12.4	11.5	7.9
Kurgan Region	9.2	10.4	12.4	4.2
Sverdlovsk Region	11.3	18.3	15.0	8.5
Tyumen Region	8.4	5.8	9.8	8.0
including:				
Khanty-Mansi Autonomous Area — Yugra	11.1	5.3	7.5	5.0
Yamalo-Nenets Autonomous District	4.0	6.5	10.9	7.4
Tyumen Region without its autonomous areas			12.4	12.3
Chelyabinsk Region	12.7	13.9	9.9	9.2

Compiled by using Regions of Russia: Socio-Economic Indicators. 2007. Statistical Book. (2007). Rosstat. Moscow, 991 p., P. 822–823; Russian Statistical Yearbook. 2016. Statistical Book (2016). Rosstat. Moscow, 725 p., P. 1044–1045.

[5] Rossiyskiy statisticheskiy ezhegodnik. 2016. Stat. sb. [Russian Statistical Yearbook. 2016: Statistical Book]. (2016). Rosstat. Moscow, 203. (In Russ.)

Its dynamics also do not inspire much optimism. For Russia in general, it was 8.8 % in 2000. By 2005, it rose slightly to reach 9.7 %. But, later, it began to decline and was 9.3 % in 2015 (Table. 3). These figures are low on their own. But the main thing is not that they are low, but rather the fact that they did not rise, despite the increase in the number of employees with higher education.

The picture for individual regions is even more sad (Table 3). For example, in the Ural Federal District, the indicator of the innovative activity of organizations declined from 10.6 % in 2000 to 7.9 % in 2015. A more than twofold drop was reported in Kurgan Region. A significant decline occurred in the industrialized Sverdlovsk Region and Chelyabinsk Region. Of course, one could rejoice for Yamalo-Nenets Autonomous Area. But it would be a sad joy because, even after rising from 4 % in 2000 to 7.4 % in 2015, the attained level did n0t even reach the average for the Ural Federal District.

Conclusion: The analysis of two important indicators of intellectual and technological development of Russia and its regions (the share of Russia in the global exports of intellectual products and innovative activities of its organizations) shows that, in Russia, the investments in higher education do not convert into technological growth.

3. Main reasons for the poor conversion of the growth in the number of employees with higher education into the technological growth

So, the question is why the growth in the number of employees with higher education fails to convert into the technological growth of Russia and its regions?

A reason for this situation could be insufficiently developed creative abilities of university graduates. To some extent, this can be explained by the official purpose of the higher education system. As stated in the Federal Law On Education in the Russian Federation, it is aimed at ensuring the training of highly qualified personnel for all basic areas of socially useful activities in accordance with the needs of society and the state, and meeting the needs of individuals in intellectual, cultural, and moral development[6]. The training itself is based on federal state educational standards, educational programs and educational publications approved by the Academic and Methodological Association of the Ministry of Education and Science of the Russian Federation. Rather than creating new knowledge, all these educational documents provide for the transfer to the students of existent scientific information recognized by the academic community.

There is no doubt that such focus of the education is correct because, before starting to create something fundamentally new, it is necessary to know both the history of the problem to be solved and cause-and-effect relationships in the phenomena and processes. The importance of developing the creative abilities of future employees is implied by the educational and methodological documents. However, this result is usually achieved in a limited number of cases due to personal characteristics of individual teachers, their talent and authority rather than any special methodology.

As we can see, the higher education is based primarily on the transfer of past scientific knowledge. It implies the training of the individual to acquire the relevant competencies and high-quality knowledge of cause-and-effect dependencies in nature and society, but within the framework of established scientific concepts currently shared by the majority in the scientific community.

In addition, the increase in the number of university graduates is not always accompanied by the adequate growth of their professional competence. While recognizing this, we still believe that even a weak specialist with higher education diploma is more knowledgeable in certain matters than, for example, a specialist with general secondary education. A higher number of graduates objectively builds in the country a positive intellectual background, where the quantitative processes gradually evolve into qualitative changes. Naturally, this would require considerable time, but the important thing is that this process is real.

Another reason is the excessive number of graduating bachelors of arts, specialists, and masters in Economics, Humanities, and related specialties (Table 4).

This problem emerged in the early 1990s, i.e., since the very beginning of economic reforms. In 2015, while the total number of graduating bachelors of arts, specialists and masters was 1,109.9 thousand, 331.6 thousand graduates, or 29.88 %, majored in Economics and Management. 166.5 thousand graduates, or 15 %, majored in Humanities.

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[6] Ob obrazovanii v Rossiyskoy Federatsii [On Education in the Russian Federation]. Federalnyy zakon ot 29.12.2012 № 273-FZ. S izm. 29 iyulya 2017 g. (st. 69, p. 1) [Federal Law No. 273-FZ of December 29, 2012. As amended on July 29, 2017 (Clause 1, Article 69)]. (In Russ).

Table 4

Graduating bachelors of arts, specialists, and masters by groups of specialties in 2005, 2010, 2015

Indicator	2005	2010	2015	2015, %
Total, thousand people	978.4	1177.8	1109.9	
including by groups of specialties:				
Physics and Mathematics	11.8	9.7	21.2	1.91
Natural Sciences	13.7	13.0	23.0	2.07
Humanities	145.1	178.9	166.5	15.00
Social Sciences	11.2	16.4	33.5	3.02
Education and Pedagogy	129.0	116.3	97.0	8.74
Healthcare	28.2	33.3	35.0	3.15
Culture and Arts	16.4	18.7	20.8	1.87
Economics and Management	292.7	386.7	331.6	29.88
Agriculture, Forestry, and Fisheries	34.8	35.1	45.6	4.12
Energy, Power Engineering, and Electrical Engineering	22.0	24.0	32.6	2.94
Metallurgy, Mechanical Engineering, and Materials Processing	25.8	24.0	30.1	2.71
Transportation	29.4	34.7	36.5	3.29
Instrument Engineering and Optical Engineering	7.1	7.4	7.7	0.67
Electronic Engineering, Radio Engineering, and Communication	15.1	14.7	16.6	1.49
Automation and Control	11.4	14.1	16.5	1.49
Computer Science and Computer Engineering	17.7	22.3	36.1	3.25
Chemistry and Biotechnology	10.7	11.0	13.4	1.21

Compiled and calculated by using Russian Statistical Yearbook. 2016: Statistical Book. (2016). Rosstat. Moscow, 725 p., pp. 207–208.

At the same time, only 7.7 thousand graduates, or 0.67 %, majored in such technologically important areas, as Instrument Engineering and Optical Engineering; 13.4 thousand, or 1.21 %, in Chemistry and Biotechnology; 32.6 thousand, or 2.94 %, in Energy, Power Engineering and Electrical Engineering.

The third possible cause is more alarming, as it could be that our society does not need so many highly qualified specialists, because the workers with medium qualifications are sufficient for using the manufacturing technologies available in Russia. "There is still the problem of immunity of the economy and society to innovation, which hinders the practical use of R&D results."[7] This could be related to the widespread use of "imported" technologies, which require only the ability to maintain them. This means that, in Russia, we see the gradual curtailment, fading of technological progress at its current intellectual level, and that, in Russia, the real priority is given to low-tech rather than the high-tech manufacturing.

We need to finally understand that the level and quality of education are determined by the production needs rather than the wishes of individuals. It is important to know these needs not just for the next few years, but for 10–15 years ahead. Amid the saturation of the market by the specialists, the society has to do this work not only for the rational spending of national income, but also to control the process of reducing the unemployment.

The mismatch between the needs of society in specialists with higher professional education and the supply of such specialists on the labor market indicates a crisis in the organization of the education system. A way out of this situation is to create a new model for quantitative and qualitative training of qualified specialists. Naturally, the spontaneous professional orientation of young people will remain in the future. However, an intellectually developed society should introduce to the process of its further intellectualization the elements of conscious foresight for the rational parameters of population employment, ensuring that its structure includes the representatives of technical, as well as socio-cultural specialties, including education, health, science, literature, and arts.

[7] O Strategii nauchno-tekhnologicheskogo razvitiya Rossiyskoy Federatsii [On the Strategy of Scientific and Technological Development of the Russian Federation]. Ukaz Prezidenta Rossiyskoy Federatsii ot 01.12.2016 g. № 642 [The Decree of the President of the Russian Federation No. 642 of December 1, 2016]. (In Russ).

Table 5

Training of qualified personnel in the Russian Federation in 1990, 2000, 2010, and 2015

Indicator	1990	2000	2010	2015	2015 compared to 1990 (–) decline, (+) growth
Qualified workers and employees					
total, thousand people	1,272	763	581	368	(–) 3.46 times
per 1000 employed, people	169	118	86	51	(–) 3.31 times
Mid-level specialists					
total, thousand people	637	579	572	446	(–) 1.43 times
per 1000 employed, people	85	90	85	62	(–) 1.43 times
Bachelors of arts, specialists, masters					
total, thousand people	401	635	1,468	1,300	(+) 3.24 times
per 1000 employed, people	53	99	217	180	(+) 3.39 times

Compiled and calculated by using Russian Statistical Yearbook. 2016: Statistical Book. (2016). Rosstat. Moscow, 725 p., pp. 184–185.

The fourth reason constraining the intellectual and technological development of Russia is the decrease in the number of skilled workers and mid-level specialists, who can service the intelligent technological equipment and various high-tech processes.

The owner of a medium-sized industrial company once told me that the final output of his enterprise rests on the capable hands of two highly skilled workers of retirement age. When they receive their wages and, for several days, fail to appear at work, this is not viewed as absenteeism. Moreover, the workers are not reprimanded, and they are welcomed back as the "dearest guests".

The Table 5 shows that Russia has practically lost its skilled workers and employees, as well as mid-level specialists. The unprecedented growth in the number of employees with higher education hampers the training of "clever pairs of hands" required to perform the relevant production and technological operations.

The analysis above showed that the higher number of employees with higher education leads to a change in the functions of the higher education. It stops to exercise the function of training the creators of intellectual innovation and gradually makes the transition to the function of training the users of innovation. Such changes in the function of higher education are also evidenced by the contemporary legal acts in Russia. For example, from September 1, 2013, the graduate studies, which previously were the form of training the scientists, was turned into a form of training personnel of highest qualification under the programs for training the scientific and teaching staff, that is, they have become the third stage of higher education[8]. The doctoral studies are still a form of training the scientists.

All of the above allows to make the following conclusion. Despite its flaws and problems, the higher education is increasingly focused on implementing an important social development function. It means that, amid the growing numbers of those who have it, the higher education mainly acts as an enhancer of the general intellectual and cultural education of the Russian society.

4. Creators of Intelligent Technology as Key Personnel for Intellectual and Technological Development of the Society

The gradual change in the function of higher education makes increasingly relevant the problem of training the human resources that should ensure the intellectual and technological development of Russia and its regions. Hereinafter, I will call them the creators of intelligent technology. If the higher education is preparing the workers who must know the established facts and cause-and-effect dependencies of their existence, the creators of intelligent technology have to go a little further. Their task should include the need to create additional knowledge, or the knowledge that did not exist before, and use it as the basis to develop the relevant new technology for practical use.

The creators of intelligent technology are the aggregate of employees professionally engaged in generating new hypotheses, concepts, and theories, which would allow to explain emerging issues,

[8] Ob obrazovanii v Rossiyskoy Federatsii [On Education in the Russian Federation]. Federalnyy zakon ot 29.12.2012 № 273-FZ. S izm. na 29 iyulya 2017 g. (st. 33, p. 4; st. 10, p. 5, pp. 4) [Federal Law No. 273-FZ of December 29, 2012. As amended on July 29, 2017 (Clause 4, Article 33; Clause 5, 4, Article 10)]. (In Russ).

contradictions, and inconsistencies in the understanding of natural phenomena and social life, as well as creating new technology for practical use. This definition is close to the interpretation of the term "researchers" which, in official statistics, refers to employees professionally engaged in the research and development and directly involved in the creation of new knowledge, products, methods and systems, and management of these activities.

The difference is that the creators of intelligent technology are required to focus on translating their scientific and theoretical achievements into practical activity. On the other hand, the researchers can also produce negative results in line with a postulate of science stating that "a negative result is also the result".

Intelligent technology means newly created knowledge, new methods to transform the products, processes, services, as well as existing knowledge that was transformed into technologically new or improved products, processes, services introduced in the market. The economic practices in Russia also differentiate the fundamentally new technology. This includes the technology that has no analogs in Russia or abroad, was designed for the first time and has qualitatively new characteristics that meet or exceed the modern requirements. For Russia, the new technology is a technology that has no domestic analogs.

The intelligent technology is not confined exclusively to technological innovation, which includes new or improved methods and processes for creating the products and providing the services. In accordance with the Russian practices of statistical monitoring, the intelligent technology may include other types of innovation. There is product innovation viewed as technologically novel or improved products with manufacturing applications. There is process innovation, which mainly includes the methods of logistics and procurement. Marketing innovation refers to new or significantly improved methods for promoting the products and services in the markets, including the design, presentation, and preparation of new pricing strategies. There is also organizational innovation that includes new methods of business management, workplace organization or external relations. Environmental innovation refers to novelties aimed at improving environmental safety both in the manufacturing processes and the use of innovative products[9].

The deployment of intelligent technology should not be viewed only as an organizational and mechanical action. It should be seen as the result of efforts made by the human intellect. The proper organization of everything is not enough. It is necessary to have people who know the essence of smart technology, and this requires the continuous training of engineering personnel that is intellectually capable to understand, creates, and services such technology [4].

The problem of training the creators of intelligent technology is part of a broader problem, namely, the problem of building the leading technological development of Russia by regularly creating fundamentally new technology (i.e., the technology developed for the first time in the world) and presenting it to the world market.

The main difficulty in training the creators of intelligent technology is to form their scientific thinking. First, such thinking implies that the subject of scientific thinking refrains from imposing his familiar and comfortable conceptual framework on nature and society, but instead follows the nature and society to identify their true cause-and-effect dependencies and trends, rather than what he finds personally desirable. Secondly, he should refrain from suppressing the fundamental novelties proposed by others, just because they contradict his own understanding of the essence of phenomena and processes. Everyone should be equal before the science. This principle proclaimed by me is stubbornly rejected by most researchers that I personally know. They believe that a scientist with experience and authority is more "savant" than beginner researchers with their newly substantiated concepts.

5. Scientific Education: Substance and Condition of Realization

Since the higher education, as already noted, is gradually losing its function of training the creators of intelligent technology and becomes an enhancer of general intellectual and cultural education of the public, there must be some other kind of education that will be aimed at preparing the creators of intelligent technology. In our opinion, to ensure the emergence of real creators of intelligent technology (moreover, to ensure that this becomes a mass phenomenon rather than a few individual cases), it is necessary to develop the special scientific education. It should co-exist with the higher education.

[9] Rossiyskiy statisticheskiy ezhegodnik. 2016. Stat. sb. [Russian Statistical Yearbook. 2016: Statistical Book]. (2016). Rosstat. Moscow, 532. (In Russ).

The scientific education is usually considered from the standpoint of pedagogy, for example, as a "purposeful process of training and education" [5, P. 119], or as the "development of abilities for scientific creation" [6, p. 35]. This understanding reduces it to the formation of creative abilities in the process of professional training of specialists.

However, the author believes that the scientific education consists in the formation of research thinking, i.e., the thinking which should be able to create the knowledge gain. The scientific education should result in the ability to not only "question everything", but also to go beyond the strict framework of usual understanding of the essences. Currently, there are no special methods to realize such understanding in scientific education. It is possible to start their creation, when the idea that scientific education can independently co-exist with the higher education will be accepted by the scientific community and state authorities that administer the scientific and educational activities.

At the same time, an important starting point for the formation of scientific education should be a provision stating that it is acquired by the individual through practical participation in scientific research. An employee directly involved in such activities perceives the methods of searching for the truth by observing the actions of other researchers, through the system of special scientific and methodological "coaching", through practical personal research efforts, as well as by additional studying of scientific literature and developing personal scientific thinking.

If the higher education is focused on transferring the existing knowledge to those who enter into adult life or want to get acquainted with a new area of knowledge, then the scientific education is aimed at developing the skills and habits to generate new knowledge.

The aspiration for knowledge (the attainment of established truths) and the aspiration for new knowledge (yet unknown to human society) are the aspirations for different types of knowledge. The introduction of such concept as "scientific education" into the scientific circulation and its distinction from the concept of "higher education" will allow not only to develop the methodology for explaining the absence of direct unambiguous link between the intellectualization of society through higher education and the growing number of new intelligent technologies, but also will allow to identify the measures for training the creators of intelligent technology.

It is important to understand that the creation of breakthrough technologies, such as those that never existed in practice, will occur only when their creators will rely on a new vision of essences. Thomas Kuhn (1922–1996), the American philosopher and historian of science, was right when he argued that the scientific revolution represents a "shift of professional requirements" [7, P. 29], which he understood as the boundaries of assumptions well-established in the scientific community. The creator of intelligent technology must always be prepared to re-evaluate the established ideas about phenomena and processes or their individual and even minor details. The new horizon in the vision of problem or a new perspective on it always leads to a new understanding of that problem followed by the creation of new technology. But, while aspiring for the future, one should not abandon previous theories up until the point when they are completely refuted by the practice. This is known as "a requirement of continuous growth" of science [8, p. 368] described by Imre Lakatos (1922–1974), an English philosopher and the author of the theory and methodology of research programs. This is why we should share the opinion of the famous philosopher and sociologist Karl Popper (1902–1994), who created the theory of the growth of scientific knowledge and once said: "Those among us who are unwilling to expose their ideas to the hazard of refutation do not take part in the scientific game" [9, P. 349].

Scientific education generates scientific knowledge, the role of which is constantly increasing. Francis Bacon (1561–1626), the English philosopher who made a lot of efforts to establish the link between the knowledge held by people and their welfare, wrote in his novel "New Atlantis" (1623–1624) that the Golden age can be achieved through enlightenment, development of trade and technology. In "The New Organon" (1620), another of his famous works, he argued that "human knowledge and power are the same things, because ignorance of cause frustrates effect" [10, P.12]. Henri Saint-Simon (1760–1825), the French thinker, believed that the welfare of people "can only result from the progress of science, fine arts and crafts" [11, P. 432]. Auguste Comte (1798–1857), another French scientist and philosopher who founded the doctrine of positivism and wrote a lot about science and its role in social development, noted that the science should "know in order to predict" and that it provides "intelligent way out of the endless social crisis" [12, p. 19, 40].

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At the same time, it should be emphasized that scientific education can happen only when complying with one very important condition, such as the communication in the same intellectual and technological language. This requires more or less similar conditions for the intelligent problem-solving. They include not only the general intellectual level of society, its culture, mindset, customs, traditions, but also the unification of participants by common research subject. When considering this side of the scientific education, Thomas Kuhn wrote that "people raised in different societies, in some cases, behave as if they see different things." He further continued that, "to the extent, of course, that individuals belong to the same group and thus share education, language, experience, and culture, we have good reason to suppose that their sensations are the same" [13, P. 247, 248].

The conclusion from the above is that new intelligent technology can come only with the development of scientific education, and such education results from actively expanding scientific research and growing number of researchers.

6. Scientific Research and Development: The Motion Vector

Since the scientific education occurs when the employees engaged in research and development participate in scientific research, let us consider the motion vector established in this area.

The statistical data reveal not just some emerging negative trends but large-scale destructive processes in the organization of scientific research.

First, there is an accelerated reduction in the number of employees engaged in research and development. Table 6 shows a very sad picture of the state of Russian science.

Table 6

The number of employees engaged in research and development in Russia in 1992, 2000, 2010, and 2015 (people)

Indicator		1992	2000	2010	2015	2015 compared to 1992
Total number of employees		1,532,618	887,729	736,540	738,857	(–) 2.07 times
including:	researchers	804,011	425,954	368,915	379,411	(–) 2.12 times
	technicians	180,702	75,184	59,276	62,805	(–) 2.88 times
	support personnel	382,205	240,506	183,713	174,056	(–) 2.19 times
	other personnel	165,701	146,085	124,636	122,585	(–) 1.35 times
Average annual number of employed in the Russian Federation (thousand people)		71,068	64,517	67,493	68,389	
Share (%) of employees engaged in research and development in the average annual number of employed		2.16	1.38	1.09	1.08	(–) 2.00 times

Compiled and calculated by using Russian Statistical Yearbook. 2003: Statistical Book. (2003). State Statistics Committee of the Russian Federation Moscow, 705 p. P.525, 130; Russian Statistical Yearbook. 2016: Statistical Book. (2016). Rosstat. Moscow, 725 p., P. 506, 106.

In 1992–2015, the total number of employees engaged in research and development decreased by 793,761 people. This means not only that every second researcher abandoned the science, but also indicates the loss of a huge number of creative people specifically and professionally engaged in ensuring the progress for Russia. It turned out that they were no longer needed. The fact that, over the same period, the number of researchers decreased by 424,600 people, or 2.12 times, reveals an even bleaker picture. These people who, by definition, were the creators of technology for the "bright future" became no longer needed for their own state.

Moreover, with each passing year, the most technologically and intellectually advanced social strata becomes increasingly thinner not only in absolute but also in relative terms. Its share in an average annual number of employed in the economy declined from 2.16 % in 1992 to 1.08 % in 2015, i.e., by 2 times.

Secondly, the complex processes are underway in Russia when it comes to dynamics in the number of organizations involved in research and development. Although since 1995 their number has somewhat increased, the structure is changing in a negative direction.

The data in table 1 show that in 1992–2015, the overall number of organizations involved research and development decreased by 380 units. For 1992, there is no data by individual sectors of activity, because the business sector did not exist at that time. This is why the other data are presented since 1994.

Table 7

The dynamics in the number of organizations involved in research and development in the Russian Federation by sector of activity

Year	Number of organizations involved in research and development				
	total	by sector of activity			
		state	business	higher education	non-profit organizations
1992	4,555	n/a	n/a	n/a	n/a
1994	3,968	1,150	2,300	511	7
1995	4,059	1,193	2,345	511	10
2000	4,099	1,247	2,278	526	48
2010	3,492	1,400	1,405	617	70
2015	4,175	1,560	1,400	1,124	91
2015 compared to 1995	(–) 380	(+) 410	(–) 900	(+) 613	(+) 84

Compiled and calculated by using Russian Statistical Yearbook. 2003: Statistical Book. (2003). State Statistics Committee of the Russian Federation Moscow, 705 p. P.523; Russian Statistical Yearbook. 2016. Statistical Book. (2016). Rosstat. Moscow, 725 p., P. 523, 503.

The further examination of the table leads to two major conclusions. First: Russian businesses are actively leaving the sphere of scientific research. After the initial rush towards R&D, Russian businesses felt that the costs failed to generate the expected profits and began to quickly leave this area of activities. In 1994–2015, their number decreased by 900 units, or by 60.9 %. This means that Russian businesses have no appetite for spending on research activities. Unlike the Western companies, they want to buy the finished results. Of course, this behavior corresponds to the nature of business. But Russian businesses do not want to understand that the methods for generating high and stable income have already changed. Amid the intellectualization of the manufacturing, a business cannot rely only on national scientific achievements that occur accidentally and spontaneously. This requires the purposeful activity to create the favorable internal scientific and commercial environment for the activities of the company. It has been long understood by Western entrepreneurs who began to establish special research units in their companies or in collaboration with research institutions.

The second conclusion is that research organizations are gradually moving to the universities. In 1994–2015, the number of research organizations in the universities increased by 613 units, or 2.2 times. This process is not negative per se. But, while welcoming this process in general, we should mention that, so far, it is not consistent with the science organization system existing in Russia. The ongoing transition of research from scientific institutions to universities under the Western models does not increase the effectiveness of research in proportion to the growing number of research organizations. Historically, the Western countries have a different system for organizing the scientific research. Unlike Russia, they have no special state academic research institutions. The science there was, from the very beginning, concentrated in the universities. In addition, its funding is to a lesser extent than in Russia dependent on the state budget. The provision of labs with research materials and equipment is many times higher than in research organizations that appear in the Russian universities.

Russia is waiting for new technology made at home. But the number of those who can create it decreases so rapidly that the emergence of new ideas is shrinking to the bare minimum. In the environment when the expansion of knowledge and birth of new technology depends on the collective mind of many researchers rather than on individual scientists, only the increasing number of researchers can generate the atmosphere for intellectual and technological development.

Let me finish my reflexions by turning once again to one important idea of Henri Saint-Simon. As someone who paid great attention to the role of science in the development and transformation of human society, he once wrote, although somewhat grandiloquently but still justifiably, that "science is useful, because it gives the opportunity to predict and because scientists stand above all other people" [14, P. 126]. If the society really wants to become a high-tech one and not only to declare such desire, it must put science and scientists in a privileged position. This means not only paying high wages, although it should be done too, but rather the creation of opportunities for commercializing their intelligent technology.

Translation

7. Conclusion

This above analysis suggests that the main fallacy in understanding the ways of ensuring the intellectual and technological development of Russia includes the view that the growing number of employed people with higher education will ensure the occurrence and implementation of technological breakthrough. In other words, the quality characteristics are attributed to the quantity.

The practice shows that increasing the degree of technological development is not determined by the general public intellectualization (which is also important), but by the social strata directly affecting the generation of technological innovation and its introduction to the society. The first among them are the creators of intelligent technology.

The scientific education is the method for preparing the creators of intelligent technology. New ideas and critical thinking can be elaborated only in the process of research activities. The support for scientific education preserves the quest for research in the society, generates the spiral of scientific and technological progress, raises the civilized nature of society and improves the labor productivity.

To preserve the invigorating atmosphere research traditions, it is necessary to increase the funding of science and investments in the creators of intelligent technology. This ensures the improvement of scientific knowledge and intellectual and technological development of the economy. We should not think that people have innate ideas (Plato, Descartes), or that the "knowledge is recollection" and therefore, the ideas will be extracted by themselves over time from the depths of the soul and offered to society without no additional financial costs.

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