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Trends in digitalization of education and training for industry 4.0 in the Russian Federation

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Abstract. In the paper, the authors consider the development trends in digitalization of education and training for industry 4.0 in the Russian Federation. The widespread use of digital technology in education is driven by specific new goals and objectives, new internal resources of the country (including experience), shortcomings in the forms and structure of employment, threats in the demographic sphere and other challenges of the external environment. An analysis of the mathematical model the use of digital technology in education of the distance learning led to the conclusion that, the success of training depends on individual properties of the trainee which are quantitatively estimated by a system indicator of quality of training.

1. Introduction

Today Russia faces the challenge of implementing and managing innovation processes at all levels and stages of social production. Implemented innovations are inefficient, the costs of developing an innovative product are not profitable, innovative ideas in the process of their development and improvement become obsolete. According to the study, prepared for the International economic forum (Saint Petersburg, 2018) the experts recognized a lack of management personnel capable of implementing innovation projects, and the lack of employees capable of innovative activity one of the key reasons for this situation.

The question arises of the means to achieve the goals of formation, growth and development of product strategies, and on their basis - the achievement of national strategic goals. Among all the means, which traditionally include finance, scientific knowledge, natural resources, production base, etc., the key means is human capital both at the level of the country and regions, and at the level of economic entities. This is a universal resource, thanks to which Russia will be able to competently create and use other resources and eventually take the position of a world intellectual leader.

Despite the fact that today the number of University students per 10 thousand people, Russia is confidently ahead of almost all countries of the world, the quality indicators have decreased significantly. University teachers complain about the poor quality of training of school graduates. In turn, employers not only criticize the level of training of graduates (especially technical), but are forced to finish their studies on special programs, sometimes spending tens of thousands of dollars on a new young “specialist”. In sociological surveys conducted in Russia in 2018, in response to the question, the
lack of what resources hinders the development of the economy, the majority of Russian entrepreneurs called not money, not raw materials and not even technology, but the shortage of qualified personnel, especially competent economists and managers.

In other words, there is a paradoxical situation in the country when the quantitative supply of specialists in socio-economic disciplines clearly exceeds the demand for them, and at the same time the demand for competent managers and specialists in economic and legal specialties exceeds the supply of such. Modernization should become a national strategy - only in this case the mobilization and concentration of all resources of the country to solve the tasks will be provided. It can be concluded that the socio-economic development of the country requires well-trained specialists in the priority areas of development, as well as a sufficient number of people with leadership qualities, the ability to adapt to new technological, industrial, economic and social realities.

2. Trends in the use of digital technologies in education in our country

The widespread use of digital technology in education is driven by specific new goals and objectives, new internal resources of the country (including experience), shortcomings in the forms and structure of employment, threats in the demographic sphere and other challenges of the external environment. These challenges required a conceptual response from the country's leadership, public administration and private business, which resulted in the development of a number of policy documents, especially the strategy “Digital Economy of the Russian Federation”. This strategy can and should be implemented for the development of all sectors of the country's economy (as national product strategies) as a balanced symbiosis of modernization of traditional sectors of the Russian economy (oil and gas, raw materials, agriculture, transport, etc.) and the accelerated development of high-tech industries and innovative products.

We must begin with education, with a system of spiritual and moral education based on Patriotic and conservative values. For the formation and innovative development, it is necessary to create an education system that will help to instill in people the knowledge and personal characteristics necessary for the creation of an innovative economy.

It is necessary to pay attention not only to students of universities and colleges, but also to schoolchildren and even children of preschool age, because they will be the need to continue the modernization of the country today. In addition, it should be born in mind that children are primarily brought up in the family, so it is also important to form the mood and desire for change in the older generation.

The total volume of the market of additional educational services for schoolchildren is estimated to 130.3 billion rubles at the end of 2018. According to our estimates, the average rate will increase by 2-3% per year and by 2021 will reach 149.2 billion rubles (+13% to the current value).

The calculation of the market was based on the average intensity of employment throughout the year and from the average check for additional education services. The educational cycle lasts on average about six months a year. The average check, according to our survey, is 3.6 thousand rubles per month.

The amount of monthly expenses depends on which organization or specialist provides these services: for example, classes with Tutors cost an average of 4.9 thousand rubles per month, classes at courses at the University — 6 thousand rubles, in ordinary courses the average check is 4.5 thousand rubles, and classes with a school teacher cost about 2.8 thousand rubles per month.

The order of the cost of additional classes depends on the type of settlement. In cities with population from 50 thousand to 250 thousand 250 thousand to 1 million, the monthly cost for these services is about 3.5 thousand. Note, that in such cities the audience of further education are the most numerous. The average check reaches its maximum in Moscow-about 8.1 thousand rubles per month.

At table 1 The structure of the education market in the Russian Federation in 2018 is listed.
Table 1. The structure of the education market in the Russian Federation in 2018.

|                          | Preschool education | General secondary education | Additional school education | Higher education | Secondary vocational education | Additional vocational education | Language training |
|--------------------------|---------------------|-----------------------------|-----------------------------|------------------|-------------------------------|-------------------------------|------------------|
| billion r.               | 548                 | 699                         | 149                         | 336              | 175                           | 103                           | 31               |
| Private business share % | 9,6                 | 5,8                         | 100                         | 7,9              | 5,5                           | 73                            | 100              |
| billion r.               | 53                  | 41                          | 149                         | 26               | 9,7                           | 76                            | 31               |
| Online-education %       | 0,3                 | 1,5                         | 6,8                         | 4,4              | 1                             | 10,9                          | 10,7             |
| billion r.               | 1,7                 | 10                          | 10                          | 15               | 1,8                           | 11                            | 3,3              |

3. Features of training for industry 4.0 in the Russian Federation

For the first time, the concept Industry 4.0 was presented at the Hannover Fair in 2011 by German scientists and politicians - H. Kagerman, V.-D. Lucas and V. Walster. In 2012, the Government of Germany, in the framework of the "Strategy in the field of high technologies 2020", adopted an innovative program - Industrie 4.0. Its main postulate is the creation of so-called smart enterprises. The basic principles of the program have been developed in the national documents of other countries.

In response, Russia created the National Technology Initiative (NTI) and several of its “road maps”. The goal of NTI is to grow domestic companies for new, still emerging global markets. In 10 years, the volume of each of these markets will exceed $ 100 billion. The projects are distributed according to “road maps”, among which are “Technet”, “Aeronet”, “Marinet”, “Avtonet”, “Neuronet” and “Energetinet”.

The TechNet "Roadmap" inside the National Technology Initiative summarizes technological solutions for automation, "digitalization” of industrial production. The TechNet base unit is the Factory of the Future - a new generation production site with digital manufacturing. The planned factories of the future TechNet are divided into three categories. These are digital factories, smart factories and virtual factories. Digital factories are distinguished by the fact that all processes, from design to virtual testing of a product, occur “in digital”.

Smart factories - the next, more complex phase of the factories of the future, will work without people. The human factor and related errors that lead to a loss of quality are excluded. Virtual factories can be located anywhere and line up in production chains using the industrial Internet.

The first digital factory in Russia started working on the basis of the engineering center at St. Petersburg Polytechnic University (CompMechLab). One of its most successful projects is a protective container that has the best energy absorption characteristics in the world. This development ensures the safety of fragile equipment and can be used, for example, when conducting rescue operations of the Ministry of Emergency Situations. The factories are created on the basis of NPO Saturn, MISiS,
Skoltech and Moscow State University.

This is where technological solutions will be tested and then replicated to other industries. They will have to acquire the primary infrastructure for the launch of sites-testbeds in the automotive, engine-building, for artificial intelligence systems, to introduce a pilot-digital certification center. At the second stage (2020-2025) it is planned to enter the world markets for high-tech products.

At table 2 The experience of organizing digital factories in the Russian Federation is listed.

| Table 2. The experience of organizing digital factories in the Russian Federation. |
|---------------------------------|-------------------------------------------------|
| Automotive-1 ("NAMI")          | Development of full-scale mathematical models  |
| Automotive-2 (UAZ)              | and design of structural elements of passenger |
| Automotive-3 (VOLGABAS)         | buses of a new generation, modular platform for |
| Automotive-4 (KAMAZ)            | unmanned passenger and cargo transport,         |
| Tractor-1 (KIROVSKIY FACTORY)   | municipal vehicles                             |
| Helicopter-1 ("Helicopters of Russia") | Development of full-scale mathematical models, |
|                                 | computational research and design of structural |
|                                 | elements of a civil / military high-speed      |
| Shipbuilding-1 (Malachite Shipbuilding) | Development of full-scale mathematical models, |
|                                 | computational research and design of the        |
|                                 | structural elements of the nuclear submarines  |
|                                 | of the 4th and 5th generations                  |
| Aerospace-1 (United Rocket and Space Corporation) | Creating a distributed center of virtual tests for |
|                                 | the rocket and space industry                   |

Who will work in these factories? Machines and those who control them. Training and retraining of such specialists has already begun. In 2018, we receive more than 1,000 specialists, in 2019, twice as many, and by 2035 - 50 thousand people.

By 2020–2030, digital and intellectual production will become widespread, there will be a change in the architecture of markets, supply chains and the transition to “virtual” distributed production. As various devices equipped with sensors and sensors and connected to the Internet interact with each other without human intervention, the main sectors of the economy are transformed and the model of interaction between people and machines changes completely. Our country has a sufficient margin in such technological areas as digital design and modeling, additive technologies, new materials, Big Data and the industrial Internet, CNC technologies and hybrid technologies, robotics (industrial robots). Even the mining industry can be a technological driver with well-organized and funded research and development.

4. Modeling the use of digital technologies in education

Modeling the use of digital technologies in education will be considered on the basis of stochastic quantization of the Nerlov-Arrow model.

This model has the form of a differential equation:

$$\frac{dA}{dt} = bq(t) - kA$$  (1)

Here $A$ is the parameter of the motivational component of distance learning, $q(t)$ — the number of remotely transmitted educational information for the same period of time рекламная активность, $b$- the rate of change in the amount of knowledge of the student, $k$ — constant speed of forgetting

It is obvious that the coefficients $b$ and $k$ fluctuate, change randomly during the transition from one type of training to another.

To take these fluctuations into account, we turn from equation (1) to the Fokker-Planck equation for
the value $\rho(A,t)$ - is the probability density:

$$
\rho(A,t)dA
$$

- the probability that in the studied sample the value of $A$ is in the interval $[A, A + dA]$

To derive the Fokker-Planck equation, consider the one-dimensional continuity equation:

$$
\frac{\partial \rho}{\partial t} (A,t) = \frac{\partial j}{\partial A},
$$

(2)

where $j$ - is the probability flow is:

$$
j = \rho(bq - kA) - D \frac{\partial \rho}{\partial A},
$$

(3)

here $D$ is the probability diffusion coefficient.

Substituting (3) into (2), we obtain the Fokker-Planck equation for this case:

$$
\frac{\partial \rho(A,t)}{\partial t} = -\frac{\partial}{\partial A} \rho(bq - kA) + D \frac{\partial^3 \rho}{\partial A^3}.
$$

(4)

If advertising activity $q$ is constant: $q(t) = q_0$, then equation (4) has a stationary solution $\rho_0(A)$, which is a solution to an ordinary differential equation:

$$
\frac{d \rho_0}{dA} = \frac{bq_0 - kA}{D} \rho_0,
$$

(5)

The solution of equation (5) is:

$$
\frac{dln \rho_0}{dA} = \frac{bq_0 - kA}{D},
$$

(6)

what gives

$$
ln \rho_0 = \frac{1}{D} \left( \frac{bq_0A - kA^2}{2} \right) + C
$$

(7)

or:

$$
\rho_0 = C \exp \left\{ \frac{1}{D} \left( \frac{bq_0A - kA^2}{2} \right) + C' \right\},
$$

(8)

Formula (8) shows that it is most likely that the effectiveness of the distance learning process can be described by parameter $A$, $\bar{A}$, which is a solution to the equation:

$$
0 = \frac{dp_0}{dA} = \frac{c}{p} \exp \left\{ \frac{1}{D} \left( \frac{bq_0\bar{A} - k\bar{A}^2}{2} \right) \left( bq_0 - k\bar{A} \right) \right\},
$$

what gives
\[ \lambda = \frac{b q_0}{k} \quad (9) \]

So, we can draw undermentioned conclusion.

5. Conclusion
The analysis of mathematical model in this case allowed to draw a number of important conclusions of didactic character: the success of training depends on individual properties of the trainee which are quantitatively estimated by a system indicator of quality of training; there is a basic opportunity to the trainee to undertake functions of the teacher in a question of planning of studying of discipline that is very important in lack of experience of training and the expressed individual psychological characteristics (the increased emotionality, sluggishness); such experience of planning can be useful for the rest of life

References
[1] Akhavan P, Ale E N, Fetrati M A and Pezeshkan A 2016 Major trends in knowledge management research: a bibliometric study Scientometrics 107(3) 1-16
[2] Bozkurt A, Ozbek E A, Yilmazel S, Erdogdu E, Ucar H and Guler E 2015 Trends in Distance Education Research: A Content Analysis of Journals 2009 - 2013 The International Review of Research in Open and Distributed Learning 16(1) 1-19
[3] Cheng B, Wang M, Mørch A I, Chen N S, Kinshuk J and Michael S 2014 Research on e-learning in the workplace 2000-2012: A bibliometric analysis of the literature The Journal of Educational Research Review 11 56-72
[4] Dorofeeva A 2018 Simulation of Advertising Activity in Tourist Business 2018 IEEE International Conference Quality Management, Transport and Information Security, Information Technologies (IT&QM&IS) Year: 2018 pp 836-8
[5] Kazak A N 2017 Qualitative analysis of the mathematical model of tourism development, proposed by Casagrandi and Rinaldi Proceedings of 2017 20th IEEE International Conference on Soft Computing and Measurements, SCM 2017 Available from: https://www.scopus.com
[6] Kazak A N 2017 Investigation of properties of the dynamic model of tourism development Proceedings of 2017 20th IEEE International Conference on Soft Computing and Measurements, SCM 2017 Available from: https://www.scopus.com
[7] Lukyanova Ye Yu BSC-oriented process management system task formalization for resort and spa sphere economic units Proceedings of 2017 20th IEEE International Conference on Soft Computing and Measurements, SCM 2017 Available from: https://www.scopus.com
[8] Means B, Toyama Y, Murphy R, Bakia M and Jones K 2009 Evaluation of Evidence-Based Practices in Online Learning Structure 15(20) 1-94
[9] Schoech, D and Helton D 2002 Qualitative and Quantitative Analysis of a Course Taught via Classroom and Internet Chatroom Qualitative Social Work 1(1) 111–24
[10] Schulte M 2001 The foundations of technology distance education: A review of the literature to 2001 The Journal of Continuing Higher Education 59(1) 34-44