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Building intellectual capital of specialists in the context of digital transformation of the Russian economy

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Summary. The differences between the parameters of the digital economy currently being formed and the corresponding parameters of the outgoing industrial economy are presented. Herein it is noted that the digital transformation of economic relations ensures high competitiveness of production systems and makes it necessary to increase training of specialists who will create such systems and manage them. It is shown that nowadays the quality of the intellectual capital is becoming the basic competitive advantage of countries and their organizations. The authors emphasize that in the context of the digital economy creativity of specialists is the key parameter of strategic advantages of organizations and determines performance and efficiency of production processes. The article justifies the need for the faster transfer to the intelligent model of the sustainable development of society where personal creativity is always in demand. It proves reasonability of development of a new concept of specialists training for industrial enterprises and ways of its realization in Russian universities. It is suggested replacing the conventional model of specialists training in universities by a new flexible modular model the basic parameters of which are material and information resources, production processes, modules and services.

1. Introduction

The current stage of human development is characterized by intense building of the digital economy parameters of which fundamentally differ from those of the previously domineering industrial economy (table 1).

Table 1. Differences in parameters of the industrial and the digital economy (compiled by the authors using the data from [1]).

Type of economical system	Basic types of primary economic resources used	Domineering (emerging) factors of production
Industrial economy	Natural and artificial material resources of the organic and inorganic type; knowledge	Labor (intellectual labor), land, capital (intellectual capital), information, knowledge
Digital economy	Material, intellectual and information resources	Intellectual labor and capital, land, intelligent technologies, information (wide knowledge)



Unlike the industrial economy where the basic factors of production are labor, land and capital, the domineering factors of the digital economy are ‘smart’ technologies, intellectual labor, intellectual capital, new knowledge and information as an aggregated form of knowledge the use of which determines economic growth and sustainable development of public production above all other factors.

Here the economic growth is seen as the increase of economic goods which are produced and used by human beings in the form of products, services and other types while the sustainable development is seen as the use of natural resource potential of the Earth which does not destabilize its natural state [2].

In the digital economy which is being implemented now in the world’s major economies intellectualization and computerization of means of production are the basic tools to ensure sustainable development of the countries and their production systems and to improve the quality of people’s life (table 2). In the long run, intellectualization of production processes in the digital economy of enterprises will contribute to improvement of the resource efficiency, satisfaction of consumers with goods and services as well as the general efficiency along the whole value chain [4, 5].

Table 2. Results of innovation in various aspects of the emerging digital economy (compiled by the authors using the data from [3]).

Aspect	Results
Instruments of labor	Information and communication technologies (ICT), robots with artificial intelligence, nanotechnologies, intelligent technologies
Motive force and power	Computerization of production, robotization, renewable energy sources
Subjects of labor	Knowledge and information, nanomaterials, intellectual capital
Transport	High-speed transport, global transfer of information and knowledge
Communication means	Wireless communications systems
Agriculture	Biotechnologies, agricultural intelligent technologies
Civil engineering	Green construction, bioengineered materials
Management of science	Science as the primary source of technological innovations and development
Education	General higher education and permanent education

Economic growth and efficiency of the public production result from conscious activity of people, their skills and knowledge, expertise and social responsibility. With advancing social production relations and gradual learning of functioning mechanisms of the natural environment, the requirements to qualities of people involved in public production and hence to the quality and technologies of training of specialists in universities tend to change. The questions of what and how to teach students in universities in the digital economy context are the most urgent, but the answers to them can vary wide among both industrial enterprises and universities giving knowledge and skills to specialists-to-be.

2. Materials and methods

The specific feature of the digital economy is that it is based on knowledge and information the holder of which is the human intelligence. Hence, the quality of individual intelligence or that of collective intellectual capital rather than just the infrastructure and financial resources determines the performance of any production processes and their efficiency. Furthermore, nowadays the quality of the intellectual capital is becoming the primary competitive advantage of countries and their organizations and is valued higher than possessing natural resources.

According to the GII 2018 report [6], Russia is the 46-th among 126 countries of the world in terms of the Global Innovation Index (between Vietnam and Chile, while Switzerland is the 1-st). One of the key factors of this rating is the quality and level of education which determine on the whole the attitude of people to the natural environment, to productivity of economic activity, cultural advancement and their own safety. Thus, it is no surprise at all that in the era of the emerging digital economy, in many countries (the USA, Germany, Japan, South Korea, Russia, etc.) the primary focus is on advancement of education as the background for the intellectual capital and acquiring new knowledge (table 3).

Table 3. Percentage of people having degrees for various age groups of the population for some OECD countries and Russia, % of the population (compiled by the authors using the data from [7]).

Country	Percentage of people having a degree (for 25 to 34 year olds)		Share of the working age population having a degree (for 25 to 64 year olds)	
	2000	2014	2000	2014
Canada	48.4	57.7	40.1	53.6
Finland	38.7	40.3	32.6	41.8
France	31.4	44.1	21.6	32.1
Germany	22.3	28.4	23.5	27.1
South Korea	36.9	67.7	23.9	44.6
Norway	34.9	49.0	28.4	41.8
The United Kingdom	28.9	49.2	25.7	42.2
The USA	38.1	45.7	36.5	44.2
Russia	n/a	58.2	n/a	54.3

From table 3 it follows that the highest share of the working age population is found in such countries as Russia, Canada, South Korea and the USA, with Russia outrunning these countries to a rather great extent, i.e. by 10% in case of South Korea and the USA. However the situation is somewhat different for the 25-34 demography: South Korea ranks first while Russia and Canada share second place. It means that Russia keeps high ranks in the older age groups and is gradually losing leadership in the younger and most creative age groups.

Even more dramatic is the situation with the efficiency of application (commercialization) of results of scientific research running in some of the OECD (Organization for Economic Cooperation and Development) member countries and Russia (table 4).

Table 4. Efficiency of commercialization of scientific research results for some OECD countries and Russia in 2014 (compiled by the authors using the data from [8]).

Country	Balance of trade of technologies, mln. USD		Patent activity			Efficiency of trade of technologies ^b , %
	credit	debit	Q-ty of triad patent families ^a	Q-ty of ICT patents	Q-ty of biotechnology patents	
Canada	2620.9	1227.4	582	817	228	214
Germany	75809.6	57025.7	4706	2344	621	133
Japan	34549.4	4842.6	17116	10180	1254	713
South Korea	9764.5	15540.0	2678	5091	569	63
Norway	4515.1	2903.0	101	72	56	156
The United	45790.1	22995.4	1725	1444	479	199

Kingdom

Country	Balance of trade of technologies, mln. USD		Patent activity			Efficiency of trade of technologies ^b , %
	credit	debit	Q-ty of triad patent families ^a	Q-ty of ICT patents	Q-ty of biotechnology patents	
The USA	134325.0	90459.0	15243	17416	4491	148
Russia	1279.2	2455.8	88	282	46	52

^a Triad patent family is a patent released by patent bureaus of the USA, EU and Japan

^b Efficiency of trade of technologies for a country is calculated as an export to import ratio

From table 4 it follows that the leading countries in terms of the efficiency of commercialization of innovations (new knowledge) within the OECD members are Japan, the USA, Germany and the United Kingdom which are successfully marketing their new technologies abroad while the respective positions of Russia are quite modest.

That is why the primary task of the national universities training specialists at present is not just giving knowledge but development of skills and expertise in their effective application.

The research [9] presents a list of 16 types of basic skills, competencies and personality traits of people of the 21st century which are characteristic of specialists capable of performing very efficiently in the context of the emerging digital economy (table 5).

Table 5. Basic skills (knowledge), competencies and personality traits of high efficient people of the 21st century (compiled by the authors using the data from [9]).

Parameter	Ability
Basic skills (required to solve routine tasks)	Reading and writing (literacy)
	Natural science knowledge
	Quantitative literacy
	Knowledge of ICT and ability to use it
	Financial literacy
	Cultural and civilian literacy
Competencies (help to solve difficult tasks)	Critical thinking
	Creativity
	Communication ability
	Team commitment
Personal traits (necessary to solve tasks emerging from changes)	Curiosity
	Initiative
	Perseverance
	Capacity to adapt to changes
	Leadership skills
	Social responsibility

From table 5 it follows that the set of the above basic skills, knowledge, competencies and personal traits is quite extensive and complex, which makes it necessary to involve in specialists' training not only universities but other concerned economic entities. This is also highlighted by requirements of

Russian industrial entities for the following skills and competencies in specialists who graduate from universities at present [10]: habits of mind; ability to take decisions within the time-limit; ability to get efficient solutions in spite of difficulties and to lead the way; ability to identify problems before they arise; flexibility and variability, quick-wittedness and inventiveness; emotional maturity, resilience and self-command; deep insight into business and industrial development.

Analysis of publications [9–12] demonstrates that with emerging of the digital economy the following competencies of specialists are becoming the most demanded worldwide: critical thinking (Russia was 25th out of 43 countries in 2015), creativity (30th out of 64 countries), habits of mind and ability to get efficient solutions in spite of difficulties. As for personal traits, they are curiosity (27th out of 43 countries), initiative, perseverance, ability to identify problems before they arise, emotional resilience and self-command, social responsibility and leadership skills.

The quality criterion of a person's intellect or intellectual capital is now creativity of a person, i.e. their drive to generate new ideas, knowledge, technologies and to find new solutions for difficult tasks. Furthermore, a creative personality is notable not only for creative potential but leadership skills as well, such as curiosity, initiative and wish to make a difference in the existing order of things.

In the digital economy, creativity of corporate staff is the key parameter of their strategic advantages or competitiveness. It causes the need for generating a new intellectual model of the sustainable development which fundamentally differs from the raw-material model typical for many countries including Russia using mostly the natural resources of the Earth (table 6).

Unlike the raw-material model, the intellectual model of the sustainable development of the society is based on generating new ideas, knowledge and, consequently, on development of new technologies (innovations) which allow to raise labor productivity and to use raw materials and other resources more effectively or create new ones to replace them.

Table 6. Differences between the intellectual and the raw material models of development.

Parameter	Intellectual model	Raw material model
Strategic advantage factor	Technological leadership	Availability of raw material resources
Source of resources	Intellectual capital	Nature's storage
Demand for new ideas, knowledge, new technologies and their holders (highly skilled specialists)	High	Limited
Sphere of production of new ideas, knowledge and technologies	Advanced system of education, science and business	Restricted system of education and science
Economic structure of countries	Diverse	Conventional
Pillar of society	Middle class and citizen activism	Bureaucracy and mineral monopolies
Social relations	Social stability	Social polarization
Role of government	Government and business as active subjects of the economic and social development	Government as a mouthpiece of mineral monopolies

The intellectual model of sustainable development also implies more diverse economic structure of a country where personal creativity is in demand. Nourishing such personal quality requires availability of the diverse and advanced system of education which can develop creative specialists rather than low-level labor which are in demand in the raw-material model. Hence, the question of 'What should be taught in universities' has the only answer: 'Teach creativity'.

3. Results and discussion

In the context of the emerging digital economy, almost all countries in the world are changing the current systems and methods of training students in universities in order to develop specialists capable

of solving urgent problems of business. Similar changes are under way in Russia as well. New higher education standards [13] containing detailed lists of skills for each field of expertise which should be developed in students while learning in universities are continuously being introduced here.

Analysis of sets of skills as well as of the higher education standard requirements for conditions of training for bachelor and master degrees in technical fields shows that standard makers are targeting not at growing creative highly skilled professionals capable of generating new knowledge and developing new technologies meant to ensure strategic advantages of the national economy but at production of batches of uniform specialists who can just copy existing technologies and use conventional ways and methods of public production arrangement. In other words, the current standards are mostly aimed at producing specialists' simulators who know a little about everything rather than creative innovators who know everything about their particular field.

Creation and use of intelligent production facilities in the future will require teams of highly qualified hi-tech specialists whose training should essentially differ from the conventional format existing in universities at present and aimed at producing quite wide variety of expertise, which under the limited time of training does not allow to give them deep insight and expertise in their particular field of future work [14]. Therefore, another training system is needed which can train specialists for team work in hi-tech specialized groups required to develop and manage production processes of the digital economy where any process includes the following component systems: physical (mechanic and electric equipment), intelligent (sensors, control systems, software) and convective (ports, protocols, networks which provide communication of a product or service with remote cloud servers) [15].

Specialists to develop such componential production processes and to manage them should have quite wide range of professional expertise as a set of knowledge, skills and experience as well as the key competencies which are of primary importance for efficient performance of each componential system. In case of the conventional training system, forming of the key competencies of specialists in universities is carried out separately (i.e. in different groups, different institutes (faculties) or even in different universities) and teams capable of managing production processes efficiently can emerge only while they work together. This approach to developing the key competencies of specialists implies high time, material and intellectual expenditures. That is why we suggest another approach, which is more compatible with digital economy requirements. We call it 'The flexible modular education model'.

The essence of the Flexible Modular development of the key competencies in specialists of technical fields is as follows:

- In the first year for students in the university, specialized task groups are to be made up in view of their becoming teams in the future. These teams will be able not just to efficiently control intelligent production processes of the digital economy but continuously improve them according to new emerging requirements and challenges;
- During the first two or three years it is advisable to teach such specialized groups together for all academic subjects corresponding to the contents of the three above componential systems (modules) of the production processes in order to provide systematic insight into physical laws of their running, of technologies and mechanisms used and of management methods;
- During the following two years of training it is desirable to divide the specialized groups into modular sub-groups either by following the will of students or depending on their academic results, in order to concentrate on subjects specific for a particular module and to produce appropriate key competencies;
- At the final stage, students of specialized groups should study together again, in order to receive experience of team R&D work the results of which can make a core for the final projects (theses);
- In course of all their training time, students of specialized groups should be always busy during the day with listening to lectures, delivering or listening to reports at seminar classes as well as working at suitable laboratories and production enterprises as stand-bys.

Implementation of the suggested flexible modular education model which is capable to grow creative highly qualified specialists generating new knowledge and developing new technologies will allow the Russian economy to gain strategic advantages in the context of digital transformation. This pretty much corresponds to key trends in specialists' training by leading universities of advanced countries where they place a priority on advancement of education as the foundation for the intellectual capital building in the current context of globalization while intellectualization of production systems is the mainstream to achieve maturity of social and economic development of the countries.

4. Conclusions

Higher education should be arranged on the system level in order to build key competencies in the specialists-to-be that should be able to effectively manage intelligent production processes of the emerging digital economy. However it should be emphasized that the implementation of the flexible modular model of training specialists to have key competencies in the field of the digital economy will require the system integration of actions by universities, industrial enterprises and the government for further development of national universities up to the level which will ensure their competitiveness over the global educational market where Russia is now behind the countries intensively intellectualizing their production processes (the USA, Japan, Germany, etc.)

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