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The Economy of Smart and AI-Based Education

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Abstact: In our study, we analyze how the smart and open education is developing and what economic effect is has for the employees. As the hard framework of educational environment erodes with the online information diffusion, the ability to learn quickly becomes an important competitive advantage on the labor market. To assess the return on investment in education, we undertaken survey with 504 participants from selected Russian companies and based our analysis on the modified Mincer equation. The results suggest although there was little difference in effect on earnings for purely classic or classic plus smart education levels (about 9.5%), employees who were engaged in open education benefited from notably greater salary increase as duration of their work experience extended. Certain methodological difficulties were due to comparably short terms of open education (hours) compared to classic 1 year which may call for further investigation and extension of the Mincer models.

Key words: Open education, knowledge and competence, AI and smarts technologies, schooling effect, Mincer equation

INTRODUCTION

Information-Communication Technologies (ICT) that provide network-style interactions impose significant impact on the development of today's post-industrial society. As Castells (2010) noted, the main particular feature of information society is the network logics of information utilization. So, the concepts of network information flows, network structures and interaction come into the foreground. Economy is spontaneously transformed into a network one, i.e., into the permanently shifting "space of flows", becoming capable of non-stop renewals. With such an informational way of development, the source of productivity is knowledge which is reflected in advancing technologies of knowledge generation, information processing and symbolic communication (Castells, 2010). The borders of educational environment are eroded and its structure is constantly transformed for the current needs of society. Russian education is no exception and it witnesses the following main changes:

- Universities now must not only ensure the educational process but also become the ground for creating innovations which is impossible without unity between science and practical applications
- Consolidation of their resources to implement joint projects, create online platforms
- The emergence of possibility to form personified educational trajectories, the development of multi-level system of topical modules
- Together with classical education, the society began to employ non-formal one which may be explained by increasing competence in innovations

So, the need for new ways of obtaining knowledge emerged. Russian economy is currently quite heterogeneous and its development is associated with the fifth techno-economic paradigm (Table 1). Its core will consist of electronics, computational and fiber optical equipment, software, telecommunications, robotics, industry, gas processing and information services.

Economic relations currently transform into network integration of organizations while science is becoming the main factor for increase in productivity. This allows assuming that scientific and technological advance becomes the directly influencing factor, instead of indirect one. In the economy of knowledge, competence and network interaction, the role of the human factor also increases. In the sixth Techno-Economic Paradigm (TEP), innovative human will become the main factor for the increase of productivity in the society.

Employment is socially valuable activities of the people, ensuring satisfaction of personal and social needs, generally meaning income from labor. The traditional forms of employment based on indefinite or long-term agreement that are common for the fourth TEP,

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Table 1: Main features of TEPs

Criterion (main period)	Techno-economic paradigm Fourth 1930-1980	Fifth 1985-2035	Sixth From 2035
Difference in comparison to the previous TEP	Production: mass and serial	Customized and flexible production and consumption overcoming ecological constraints in energy and materials, de-urbanization based on ICT	Energy-saving technologies, nano-electronics, AI systems
Changes in economic relations	Prevalence of technological structures in organizations	Transition to network integration of organizations	Transition to component-based technology (heterogeneous network environment, professional relational DBMS with open interface)
Development of stake holders interaction models	B2A, B2B	B2A, A2B, B2C, C2B, B2B, B2G, G2B, A2A, A2C, C2A, C2C, G2C, G2G	B2A, A2B, B2C, C2B, B2B, B2G, G2B, A2A, A2C, C2A, C2C, G2C, G2G
Role of society in stake holders interaction models	Consumers	Consumers and partners	Consumers and partners
The main factor of productivity increase	Labor, land, capital, information, entrepreneurship	Science, innovative human	Innovative human
Popular types of education	Classical (formal) education	Classical, non-formal and open education	Classical education, smart-education with AI
Popular forms of employment	Traditional forms	Traditional and non-standard forms	Flexible employment

and supplemented by non-traditional ones in the fifth TEP such as outsourcing and outstaffing, freelancing and various flexible workday schedules. The enhancement of the network interaction ensures flexibility of labor market. In our opinion, the sixth TEP will have flexible employment as the most popular form with erosion of work-time borders, optional presence on the work place and increased mobility of labor resources.

In today's market competitive advantage can be ensured only by particular mutually coordinated competences that correspond to organization strategy (Kersiene and Savaneviciene, 2015). In the transition from the fourth to the fifth TEP, the requirements towards competence increased dramatically. New ones emerged system thinking, communication between industries, project management, lean production, programming, robotics, intelligence, client-orientation, multi-language and multi-culture capabilities, working with people and in uncertainty and artistic creativity. Although, competence in ICT is not specially listed, it's inherent in programming and robotics, ensures the communication, multi-language and multi-culture capabilities based on network interaction. The increasing requirements toward competence can be explained by the following:

- Expanding the types of innovations: breakthrough and imitation innovations were common during the industrial production stage while information (postindustrial) stage makes open innovations to thrive and merely qualification of workers is no longer enough
- The transition to service-orientation towards the society needs in economy
- The development of information society, where knowledge is considered to be the basis for production
- Convergence of technologies, introduction of robotics
- The creation of integrated virtual environment
- The emergence of global talents

For the innovative development of economy, it's necessary to create high level of potential in workers, provide economy with staff having not skills, habits or even qualification but the required competence. This is possible in life-long education which in network economy can be implemented on an open platform. If classical (formal) education system is attached to the physical place where educational institution is located, the non-formal education erases these borders. Besides such a system, the non-formal and open education is typical for the fifth TEP. So, the process of transferring the educational process into e-environment is already taking place. The questions arise if Russia is ready for the development of smart education, what will open education give to the people, if there's economic effect for people working in organizations (whether theory contradicts reality).

THE ANALYSIS OF RUSSIA'S READINESS TO INTRODUCTION OF SMART TECHNOLOGIES IN EDUCATION

The analysis of Russia's readiness to the network interaction yields clear results. According to the data of UN's department of economic and social development as well as of World Economic Forum, Russia improved its positions in the respective international ratings significantly. Its ICT development index was 49th in 2013 but already 45th in 2015 and the network society readiness index jumped from 74th to 31st, during the same

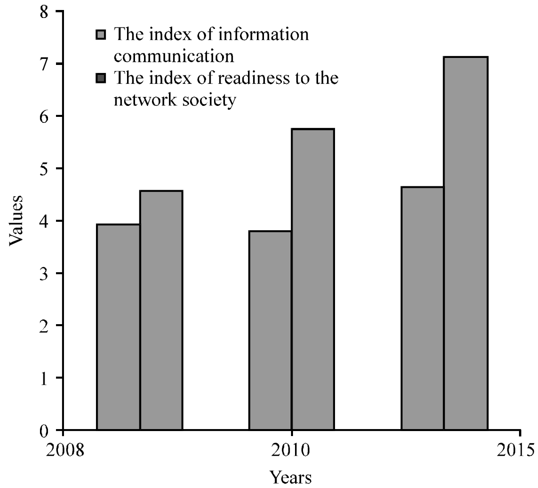

Fig. 1: The dynamics of the information society development indexes for Russia

period (for the indexes' values, Fig. 1). The development of high-organization systems and smart technologies is currently in the foreground of technological trends in Russia and the world. The prospects of smart technologies development in education are seen as the following: M2M (Machine to Machine) models, i.e., providing business processes automation and creating additional service complexes for controlling technological processes:

- Cloud technologies
- Big data
- Virtual reality
- AI development

Their development level is assessed in the "Scenario of innovative development and globalization of the Russian IT industry". The increase of the overall number of Internet users is named as the major reason for the rapid development of cloud technologies. Today, 2.5 billion people have Internet access and by 2025 this number is expected to increase 1.5 times, mostly due to decreased costs and even wider usage of smart phones. Cloud technologies dramatically transform existing business models, advancing more flexible, mobile and light-weight (w.r.t. the costs) approach. It is expected that by 2025 most IT and web applications and services will be in the cloud and the majority of companies will be using cloud platforms and services for their needs (James *et al*., 2013). In 2013, the share of organizations using cloud services was 11% and in 2014 it was 13.3% a notable but not very significant growth. Still, Russia has ambitious goals regarding smart technologies development as

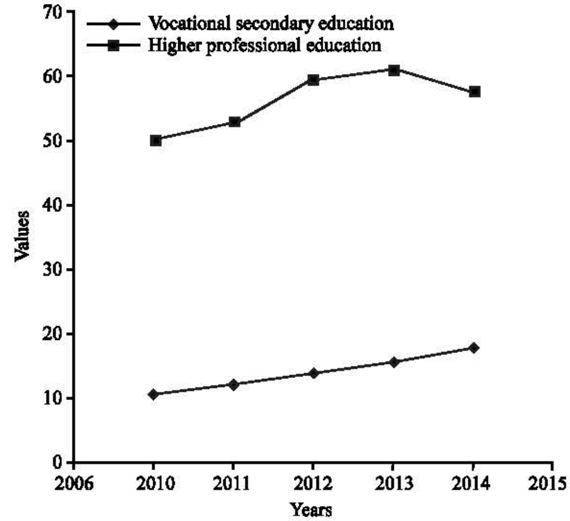

Fig. 2: The share of educational institutions providing distance educational services

reflected in the "Scenario of innovative development and globalization of the Russian IT industry". We believe that with even greater introduction of such technologies, smart education based on AI must be prevalent in the sixth TEP. Currently, Russian people have robust access to web resources, can actively interact and obtain knowledge. By the end of 2014, already 70% of Russian households and 90% of organizations had internet access. Educational institutions are increasingly providing distance educational services (Fig. 2). So, in 2014, 17.5% of vocational secondary education and 57.5% of higher education organizations implemented distance education. The disadvantage of the introduced distance technologies was their orientation towards internal needs of the organization, lack of transparency for external stakeholders. More than half of Russian universities provide distance education to students but not all of them are integrated in the whole open education system. According to dedicated surveys of the Higher School of Economics, Russian people were using the Internet to increase their competence via the following means: distance education 3%, reading and downloading online newspapers, journals, e-Books 19%, using online encyclopedias 35% (the data for 2013 were nearly the same). At the same time, 26% of Russian population is involved in life-long education according to the surveys, the main reason for that (38%) was fear to lose job or position (Aletdinova, 2015). Meanwhile, business has also started to actively use the Internet for the professional education of human resources the share of organizations using the Internet for professional training of their staff increased from about 12 in 2005 to already 29% in 2010 and remained more or less stable since then.

Massive open online courses started its development in Russia in 2013, when its leading universities started to put their courses online and the most popular open platforms are Open Education (opendu.ru) and Coursera (coursera.org). The former is created by the Association "National Platform for Open Education", established by several leading Russian universities Moscow State University, St. Petersburg Polytechnic University, etc. The following principles form the basis for the courses:

Best specialized courses by best professors. Each university offers courses within its most established majors, taught by the most advanced staff members. Quality standards. The quality of the teaching materials is guaranteed by the internal commission of experts all the courses correspond to the requirements jointly established by the project members. Organization of assessment procedures. The assessment tools are also examined by a dedicated commission while identification of users is performed via proctoring or biometric technologies. The system incorporating e-libraries, dedicated artistic and creative contests, etc. for people of various ages is also developing rapidly it is aimed towards drawing the society towards life-long education. Overall, we can conclude that network interaction is used for obtaining knowledge and competence but unfortunately the growth is not rapid enough.

ESTIMATING THE ECONOMIC FEASIBILITY OF EDUCATION

Mincer proposed the "production function" for earnings, describing the relationship between the workers' salary and his/her education level, work experience and other factors. He highlighted that if salary is taken in monetary values, then the other factors must be expressed in money terms as well (basically, amount of human capital investments in each factor). However, if the focus of interest is on relative rather than absolute effect, logarithm function for salary should be taken which permits expression of education and work experience in years. Also, in this case the factor coefficients are estimates of rates of return and volumes of investment (Mincer, 1975). For our research, we undertook a survey with 504 staff employees from selected organizations working in the Siberian Federal District. We considered two groups of participants: the ones who got classical education (206 subjects with age ranging from 34-82 years) and classical plus elements of open education (298 subjects with age ranging from 18-53 years). The share of male participants was 44.2% in the first group and 47.0% in the second one. The average salary levels were 36.9 and 28.8 thousand rubles respectively (1 rub. was equal to about 0.016 USD). The difference in salary was possibly due higher work experience of the subjects from the first group while in the second group there were some people who work and study at the same time. Besides, in the second group there were 202 distant education students, who already had vocational secondary or higher education plus some work experience. The survey of the participants of the second group allowed us to identify the popular forms of open education they were engaged in Table 2. One can see that self-education was the most widespread while the least popular was distance higher education. As the reason for the choice of the latter, the participants named their own remoteness from major cities and universities, high workload while the stated disadvantage was the inability to communicate with tutors face-to-face. To test the hypothesis of open education's positive economic feasibility, we modified the Mincer equation. We will empirically study the impact of education, gender and overall work experience on the salary level. The regression analysis was performed using the following models:

$$\ln w_i = \alpha_0 + \alpha_1 h_i^1 + \alpha_2 S_i + \alpha_3 \rho_i + \varepsilon_i \quad (1)$$

$$\ln w_i = \alpha_0 + \alpha_1 h_i^2 + \alpha_2 S_i + \alpha_3 \rho_i + \varepsilon_i \quad (2)$$

Where:

w_i = Salary for the ith participant
h_i^1 = The level of the classical education for the ith participant (years)
h_i^2 = The level of the classical and open educations for the ith participant (years)
S_i = Overall work experience for the ith participant (years)
p_i = Gender of the ith participant (dummy variable: male, 1 female)
ε_I = Remainder

Table 2: The most popular forms of open education, for the second group of subjects

Open education form	Share subjects who use (%)	Average duration of single online session (h)
Listening to open lectures, lessons, presentations	64.1	0.47
Reading openly available online materials	100.0	1.20
Installing and using training software	18.1	1.10
Watching video materials	97.7	0.47
Studying in open online courses	21.1	56.30
Obtaining higher education distantly	2.7	250.00

Tabl 3: Results of the regression analysis for the modified mincer models

Values	For the model with open education Eq. 1	For the model with open education factor Eq. 2
Sample size	206	298
Coefficient of determination	0.588	0.651
F-criteria	108.31	149.84
Coefficients		
α_0	-0.377	-0.359
α_1	0.094*	0.095*
α_2	0.029*	0.034*
α_3	0.068*	0.0699*

Significant at $\alpha = 0.01$

As we mentioned before, the survey responders were divided into two groups: the ones who only had classical education vs. the ones who had both classical education and various forms of open education, including self-education. The term of the open education varies significantly, from minutes and days to months and years, so the values for the variable were obtained from expert estimations by the participants themselves. The results of the regression analysis for the data of 2015 are presented in Table 3. All the coefficients are significant.

Based on the common Mincer equation coefficients interpretation, we may note from Eq. 1 that the rate of return from the classic education was 9.4% while for overall work experience it was 2.9%. Male employees with classical education earned 6.8% more compared to their female counterparts.

From Eq. 1, we could conclude that the rate of return from education that combines classical and open elements was nearly the same, at 9.5% but work experience clearly yielded higher growth in salary, 3.4%. The difference in male and female worker's earnings was comparable to Eq. 1, at 6.99%. It should be also noted that for Eq. 2 the R^2 was higher, at 0.651 compared to 0.588 for Eq. 1. According to Mincer, it means that variance in earnings attributed to difference in investments in human capital is higher for the case of classical plus open education.

CONCLUSION

The ICT allowed implementation of individual educational trajectories (Bao and Wenlan, 2015), joint creative activities and smart education (Loia *et al*., 2016). Smart employee is becoming the main production factor in the modern economy and his or her capability to learn faster compared to others turns into important competitive advantage. A current economy trend in Russia and worldwide is the development of complex systems, smart technologies, robotics, information services, etc. It leads to major transformations in education, when its open and smart forms, including self-education, get recognition in addition to classic ones. Indeed, already in Russia the development of ICT allows the people to freely engage in any forms of education. In our work we used the survey data for employees of selected companies from the Siberian Federal District of Russia to test the hypothesis about significant economic effect of open education. The regression analysis based on the widely recognized Mincer models showed that the return on investment for classic or classic plus open education is rather limited, both about 9.5% per additional year. The reasons for that may be the following:

- The lack of massive involvement in the open education system, when the amount of time dedicated to it was often measured in minutes and hours, compared to years generally used in Mincer models
- Rather limited sample size about 500 participants
- Unreliable expert evaluations made regarding the duration of open and self-education

RECOMMENDATIONS

As for our further research, we hope that using statistical data for several years would allow us estimate the economic effect of open and smart education more accurately. Also, more specific forms for assessing the level of open education should be employed. Still, our results show that there's a need for the development of smart education in Russia and employees who engage in corresponding activities benefit from higher earnings as their work experience level increases.

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