The Impact of Digitalization on the Transformation of Human Capital during the Development of Industry 4.0

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Abstract: *The article explores human capital management in modern society as a global phenomenon associated with the transition to a new economic order called Industry 4.0. The authors reveal the issues of organizing the educational process and the implementation of remote technologies in the Russian Federation, as well as consider new challenges faced by the national education system at all levels in the context of the pandemic. The article also assesses the prospects for further development of the education system in the context of digitalization and the transition to Industry 4.0, as well as positive and negative trends that are laid in the new changed conditions of the educational process organization. The authors raise the issue of human capital quality formation through the use of distance learning technologies.*

Keywords: *human capital, information educational environment, educational process, digitalization, online education, distant learning technology.*

I. INTRODUCTION

Education is one of the main components of the human capital management system. According to scientists, education provides an opportunity for an individual to acquire in the process of learning those abilities and qualities that become values in the development of human potential, as well as his personality, and can be used in a specific work activity to ensure the growth of the production volume and efficiency. Education dynamically follows civilizational changes developing and expanding the range of opportunities for each person.

In the context of digitalization, and the transition of humanity to high-tech development, namely, Industry 4.0, education is increasingly moving towards an online information educational environment (IEE) [1]. The authors have analyzed the scientific problem on how to organize the interaction of the educational process participants in a new educational environment to achieve the most optimal result in the development of human capital.

II. RESULTS

From traditional education to digital

The education development process was examined from traditional to information-based education (knowledge-based), and then – to virtual. The education development was considered at the following levels: pedagogy (science), the state (public development management system), and educational institutions (system of educational organizations: school, college, and university).

The main principle used in the research is a systematic approach that allowed developing a didactic model of the educational process in the framework of the concept called "Human capital management in the transition to Industry 4.0".

Numerous articles devoted to the current state of development of the education system, especially now, in the context of the pandemic and the mass transition to distance learning, reveal only superficial, unsystematic aspects not creating a general comprehensive picture. When addressing this issue, one must not forget about the scientific knowledge accumulated by pedagogy as the oldest of the sciences and the science of management.

The outstanding Russian scientist P.S. Lerner wrote: while "the goal of education is comprehensive and harmonious human development and preparation of the young generation for active social life, then the goal of learning is more specific: assimilating general knowledge by students, forming methods of activity, and scientific worldview" [2].

The Russian scientific and educational community has taken an interest in distance learning since the beginning of the 1990s, in particular, after adopting the “Concept of creation and development of distance learning in Russia” in 1995.

Two basic distance learning models can be distinguished which influenced the formation of the

distance learning system in the world. These are the British (individual) model, and an American (group) model (Table 1).

Table 1: Basic models of distance learning*

1. Models/ Criteria	1. The British model	2. American model
2. Source	The Open University of Great Britain (experience of the Soviet system of extramural education, European correspondence schools, and British traditions of vocational education)	Several major American universities
3. Mode of study	Part-time extramural learning without an instructor	Face-to-face learning via telecommunications
4. Trainees	Persons of ripe years	College and university students (student parties)
5. Educational process support	- educational and methodical complexes; - psychological and pedagogical support (tutorials, individual consulting by teachers);	- interactive communications quality control; - high-quality technical equipment;

* (Compiled by O.V. Glinkina)

The central core of the modern distance learning model is based on the technical means of the information and telecommunications system, which, according to scientists, ensure its effectiveness, bringing the quality of distance learning closer to full-time education [3].

However, the research has revealed that it is impossible to achieve positive learning results without "pedagogization" of the conceptual framework of the information and educational environment, in which distance learning is implemented. First of all, this is because the created educational products do not pass the certification, basic research as well as R&D results are not transferred to be used in practical learning that reduces their quality and characterizes only the formal aspect of availability for use in the educational process.

The training enhancement process is achieved through the technical organization in the IEE, but neither the educator (teacher, lecturer) nor the trainee (schoolchild, student) can be immediately adapted to such an innovative learning process. In the conditions of IEE, the teacher should have skills to organize the educational process, perform diagnostics of results, and possess technical means of working in an online environment. Learners are required, first of all, qualities, such as self-organization, high motivation to learn, as well as information and technology skills. At that, this implies that both categories have high-quality equipment (computer, video camera) and the ability to access the Internet.

Therefore, at present, the main problem associated with the use of distance learning technologies is the need to prepare the educational process subjects for activities in the IEE.

Education in contemporary conditions of digitalization, distance learning, and the pandemic

As early as at the end of 2015, President V. Putin issued a decree "On the national goals and strategic objectives of the development of the Russian Federation for the period up to 2024" [4], in which he justified the need to create a national system of teacher growth (NSTG). One of the aspects of the system was the creation of a mentoring system among teachers, which was supposed to promote their continuous development. In 2019, the Minister of Education F. Vasilyeva announced the creation of online courses for all categories of students within the framework of the national project "Education". But, in fact, the situation has changed little. The Teachers Trade Union has stated that currently, the situation is "very different across the country, including opportunities to access the Internet, and thus conducting high-quality classes can become possible only after creating good online platforms" [5]. They give an example that the Zoom cloud platform is switched off after 40 minutes, while the Skype messenger does not work well with large groups. Nevertheless, the Ministry of Education of the Russian Federation claims that it is the national project "Education" that allows organizing classes in a remote format. At that, in the context of total self-isolation, more than 20 online services and educational platforms are operating to support distance learning at home.

Certainly, the situation with pandemic has had the impact on the rapid growth in demand for online education in all educational institutions. At the same time, this situation revealed the main problems related to the fact that online services, with an increased load, did not cope with their functions. For example, at school, the main complaints concern the hang-up of electronic gradebook, the complexity of the interaction between teacher and pupils, poor provision of both schoolchildren and teachers with technical means, the lack of a personal computer for the child (since parents also work remotely), as well

as video cameras and video lessons with sign language for children with disabilities.

In higher education institutions, attention is also focused on an increased amount of information that students need to process independently, a large number of homework assignments, lack of free access to relevant specialized literature in some specialized disciplines (to perform tasks on laboratory work, and prepare for state exams). Teachers note that it is impossible in principle to conduct laboratory and practical classes in technical disciplines online whereas yet there are no solutions.

In some ways, universities have a certain advantage over colleges and schools when switching to an online environment, since before the quarantine, many of these institutions have already practiced distance learning [6]. At that, some university rectors even suggest that the system of education should use current situation and stay in the online environment after the pandemic, refusing to work with a "live audience", for example, when delivering lectures. But one can't do that! In the authors' viewpoint, such statements are irresponsible.

The emergency transition of traditional learning to distance learning has huge differences from properly designed and planned online learning. A high-quality educational process in the IEE should be based on a didactic model with a methodological justification of the sequence of educational materials, control, and measurement tools of learning results in an electronic format.

The main thing, in this case, will be pedagogical design as a tool for designing online courses, which is not even thought about now. The government's decision to introduce quarantine in the face of uncertainty required a quick response and adaptation of educational institutions based on the situation. Therefore, the main slogan was "survival of education", rather than its quality.

Certainly, even in these conditions, teachers find advantages in the distance learning system. According to A. Fokin, Associate Professor of Tyumen State University, "the main advantage is that for many students, the screen of the gadget removes the psychological block. They are more willing to participate in the discussion. And the requirement for high self-discipline from students is a disadvantage" [5].

It was also positive that the administration of some universities showed flexibility, allowing teachers to determine the specific forms of educational technologies provided by the university, through which they were able to interact with students. This made it possible to reach a large audience of students, including those who could not use a sustainable Internet.

Distance learning was most difficult for students of the 11th grades of schools when preparing for the unified state exam, as well as graduates of universities/colleges when they needed to prepare for state exams.

The situation that developed from March to May of 2020 has shown to everybody that the main problem is not so much the lack of infrastructure, the lack of preparedness of the educational institutions' administration and teachers to the new digital learning technologies, but that the formed models of social interaction are changing radically. Existing social ties between people of different generations break, communication between teachers and students is changing, transforming into a new format. In some families, to help a child learn online, family members are forced to join the process. At that, shortcomings in the organization of distance learning create a certain tension for everyone. It should be kept in mind that any training always requires special social technology to support the student, and online training is no exception. It is necessary to focus on the motivational factor, especially for those students who are not strongly motivated for learning. While parents can control and support (conditionally) their schoolchild, it is quite difficult to motivate a college or university student.

Today, the reality is that distance learning is mainly held in the format of a "talking head", which is very difficult for students to listen to for a long time. But it is also difficult for teachers to work at the computer for 6-8 hours a day without the possibility of getting immediate feedback. Facial expressions, looks, and live communication create a unique atmosphere in the course of full-time teaching that motivates students to acquire knowledge. Online learning is not just a formal process of translating information through the Internet environment, but a social process based on cognitive mastering of the data received.

In general, according to the Minister of Science and Higher Education V. Falkov, "the situation of the pandemic will change the system of higher education" [7]. He notes the possibility and needs to extend digital formats and create a model of mixed education. The Chairman of the Federation Council V. Matvienko also spoke about this issue, stressing that it was impossible to completely replace full-time education with distance learning. Her words that " ... nothing can replace communication with the teacher; this is a very important basic principle of our Russian school" are very exact and right [8].

Forecasts for the education system development

Speculating about the predicted options for the education system development after the pandemic, it should be noted that the system-functional approach indicates the importance of targeted activities of educational institutions towards the formation of the IEE. At that, this requires the scientific-based didactic design of educational trajectories and, above all, the creation of a general concept of the IEE-based educational system not only at the university or

college but also at school, in the context of building the state IEE.

The analysis and generalization of the obtained results of both theoretical and empirical studies allowed determining the invariant components of the IEE (Fig. 1).

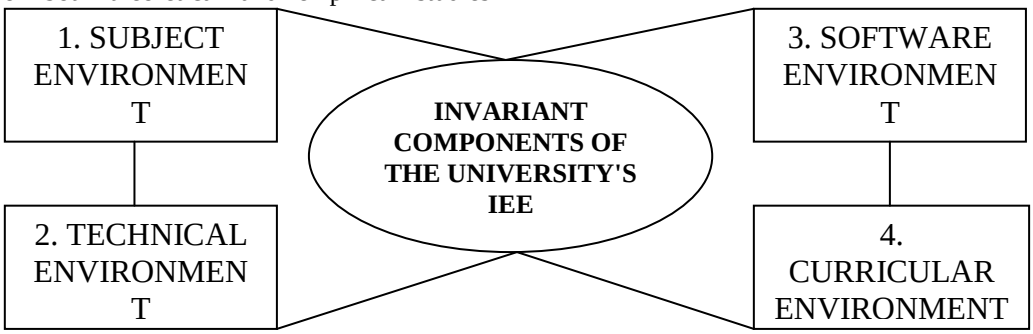

Fig. 1 Components of the IEE of the university

The conducted study has revealed that the optimal model of online learning will be the model that would integrate traditional educational technologies and distance learning, based on the training goals and objectives. At that, the teacher, who performs the supporting and motivating functions for learning, as well as interpreting learning results, was and remains a central link of training [9].

Implementation, maintenance, and development of the IEE in the learning process require implementing special training for the educational process actors to form in teacher the professional-pedagogical competence in the remote educational technologies, as well as to develop dynamic qualities (cognitive activity, self-organization, self-control) in students.

Lerner P.S. argued that a person could be formed only by the person, and not through indirect impacts, such as tutorials or computers, but the direct personal communication process.

Thus, the fundamental professional task of the teacher was and remains the formation of a highly effective, multidimensional, innovative educational environment, which takes into account the individual differences of each student, his aptitudes and capabilities.

According to D. Melnik, the research team leader of the Education Development Center of the Moscow School of Management SKOLKOVO "universities ... are poorly prepared for crises. Their emergency plans either do not exist or do not work; they do not use scenario analysis and other strategic planning tools" [10].

III. CONCLUSION

It is well known that the main reference point in training is the possibility of giving personal "educational increment to the student", which consists of his educational products (internal and external) of learning activities. In the information society, in the digital environment, the value of knowledge is rapidly decreasing because students can easily get any information from the Internet. But, at the same time, the value of the ability to understand what knowledge and where it can be obtained, how to process it and use it to solve problem tasks, how to find specific unbiased information, rather than a superficial array of blurred, inaccurate data, increases significantly.

Summing up, it can be noted that the dramatic character of the current troubled situation creates not only problems but also opportunities for the state education system and each educational institution to conduct self-diagnostics, determine the effectiveness of the digital solutions used, as well as the need for retraining of teachers, and technical modernization.

It is now, in the context of forced quarantine, that the conditions are being formed to realize the need to form comprehensive strategies for transforming contemporary education into a digital form. It is important to draw the right conclusions from such a global experiment to organize systematic correction of mistakes to eliminate them in the future. After all, it is in the course of obtaining an education that new competent specialists (labor resources) are formed, on which the future of the entire society depends.

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