

Innovative Transformation of Higher Engineering Education in Russia

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Summary

Modern society unanimously recognizes the importance of education for the constructive socio-economic development of the global economy and adopts humanistic principles for building social interaction both at the state and interstate levels. The study aims at analyzing the main directions of transforming the system of higher engineering education with due regard to the actual needs of the labor market caused by the digitalization of the economy, as well as changes in the content and methodology of implementing the main socially significant processes that ensure the vital activities of modern society.

Keywords:

innovative development; digital economy; educational process; innovative infrastructure; engineering education.

1. Introduction

The priority development of education is noted by the UN documents, in particular, the United Nations Millennium Declaration adopted at the World Education Forum held in Dakar in 2000. It says that "education is a fundamental human right. It is the key to sustainable development and peace and stability within and among countries, and thus an indispensable means for effective participation in the societies and economies of the 21st century, which are affected by rapid globalization" [1, p. 8]. This thesis emphasizes the importance of education for the development of all socially significant processes in the human community: economy, policy, culture, etc.

The right to education granted to every person in modern society is realized through the educational process since it aims at satisfying the actual needs of society in educational services that partly comply with the requirements of the economy and the labor market [2,3]. Changing needs in the content and quality of education and the formation and emergence of new social requests transform the educational process which should adapt to economic changes and transformations of life and work models in modern society [4]. As shown by statistics and its analysis, education depends on the development of the economy and socially significant processes, while economic and social development is determined by the level of education. According to the U21 Ranking of National Higher

Education Systems in 2021, which measures the achievements of countries in the field of higher education, the United States (Index 100) and Switzerland (Index 90.1) take the top spot, and Russia ranks 35 (Index 49.1) next to South Africa (Index 49.7) and Ukraine (Index 47.8) [5].

According to international rating systems, achievements in the field of higher education correlate with the Human Development Index (HDI). According to the 2021 ranking, Switzerland ranks third (HDI 0.955), while Russia is only 52 (HDI 0.824) [4]. There is a clear correspondence between the country's competitiveness on the world stage and the level of education. According to the Global Competitiveness Ranking which is based on such criteria as the state of the economy, the efficiency of the government, the state of the business environment, and the state of infrastructure, Switzerland is the leader, the USA holds the 10th position, and Russia ranks 45th. In total, 64 countries were included in the study [5]. The above-mentioned comparative analysis of strategic indicators in relation to the state and society testifies to the following statement. The competitiveness of the national economy and the economic development of socially significant processes during the digitalization of all life spheres depends on the availability of highly educated and competent specialists who are able to master, create, and develop innovative technologies that contribute to increasing labor productivity, promoting sustainable development, saving resources, and using them in an environmentally friendly manner [6].

2. Methods

This research is analytical since it is based on a comparative and problematic analysis of the current educational processes, as well as possible directions for transforming higher engineering education in Russia, including the analysis of changes in labor market requirements for young professionals and social demands on the sphere of education, which is a source of personnel formation for the country's economy. To explain logical conclusions, scientific theories, and concepts in the field of management, we referred to the economics of sustainable and strategic development, philosophy, social psychology

and pedagogy, sociology, and cybernetics, as well as the basic principles of the dialectical approach to scientific research.

The above-mentioned approaches determine the following structure of the study:

1. Human resource development in the digital economy. As noted above, economic development depends on the level and quality of education; therefore, the level of human resource development is an impetus for both short- and long-term economic development. Large-scale global changes caused by the digitalization of the economy are associated with a new industrial revolution (Industry 4.0). Its main achievements are fundamental changes in socially significant processes due to the rapid development of innovative technologies, including the use of artificial intelligence, the development of additive manufacturing, the rapid spread of new business models, as well as new production systems and ways of consumption [7].

All the changes caused by this industrial revolution and typical of the digital economy directly or indirectly transform the requirements that society places on human resources [8]. New requirements for human resources and their use in the near future are determined by changes in the labor market. High-tech production is getting automated, which is a factor in job cuts, slowing-down job creation due to the use of artificial intelligence, an increase in the polarization of the labor market due to the growing need for professionals in cognitive and creative highly profitable spheres, and a decrease in the need for low-skilled workers [9-11].

2. Determining the impact of digital technologies on the educational process. For a long time, the sphere of education had been characterized as conservative. This feature testified to the quality of national education, provided its competitiveness in the world market of educational services, and ensured the attractiveness of education for citizens, foreign students, and employers around the world. A striking example of this approach to the educational process is England which is acclaimed as a country of classical vocational education.

The new industrial revolution creates new rules for even such a conservative sphere of human activity as education. At the present stage, the development of humankind is determined by such global processes as the development and use of information and digital technologies in all areas of life, including education [12]. In countries with immense production capacities, which are based on digital innovative technologies, 80% of all labor costs are highly skilled labor. The development of digital technologies is connected with significant demand for engineering education [13]. The emergence of new innovative learning technologies, such as lifelong learning, gamification, VR and AR technologies, and free online courses from world-leading universities have changed the educational process. The use of information and digital

technologies in education has made it more practice-oriented, less labor-intensive, and more flexible, which allows the modern educational process to quickly respond to changes in the labor market [14].

3. Education as a process. Despite all the transformations in social interaction, which provoke a deeper and sometimes explosive spread of digital technologies in all spheres of life (both individual and social), education is regarded as a process and considered in the traditional format for human consciousness.

From this viewpoint, education can be considered within the framework of process management, which determines and controls the quality of business processes. Within this approach to the analysis of the educational process, it is recommended to use the classical business process model shown in Fig. 1.

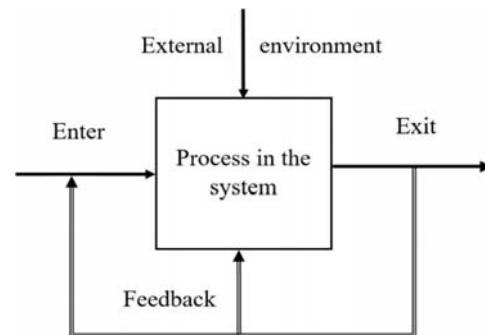


Fig. 1. The classical model of business process (educational process).

3. Results

The analysis of global changes in the educational process has proved their significance and necessity for a new industrial revolution and the development of human civilization. In modern society, including Russia, the need for highly qualified specialists (human resources) is constantly growing. This issue is especially acute for the transformation of engineering education since it is fundamental for the successful implementation of the new industrial revolution. For the effective interaction of these two global processes (the transformation of education and the implementation of Industry 4.0), it is necessary to achieve a constructive balance between people and technology. Consequently, changes that affect the requirements for the quality of human resources determine the main directions for the transformation of education and the educational process. However, they are all predetermined by changing needs of the labor market, which relate to its structure (the predominance of highly qualified creative labor), the form of employment (remote work, freelancing), and the formation and dissemination of new forms and models of employment, which leads to a

change in the requirements for professional literacy and expectations of high-level professional competences [15]. Russian higher education tries to ensure the necessary development of the national economy and to fill the shortage of highly qualified specialists, especially in the field of engineering education. Over the past few decades, it has been reformed to build a model that would be based on the principles of Russian traditional higher education, which have proven their efficiency. At the same time, they comply with the current requirements for the development of the national economy. The conflict between these two trends has ambiguous social effects on the transformation of education [16].

Soviet higher education and its basic principles were far from global practices. While adapting to Russian higher education, international models of higher education have undergone a major transformation which served as the basis for the formation of new models of higher education with due regard to national specifics. When ensuring the effective operation of a classical model of business processes, one can note the mandatory conditions that should be observed for both entry and exit resources. In the case of the educational process, entry resources are human resources with certain abilities transformed during the learning process into human resources with professional skills, knowledge, and exit competences that are relevant to the labor market and social demands. However, the transition to a two-tiered education system (Bachelor's degree, Master's degree) within the Russian education and process management technologies revealed some discrepancy, which is reflected in Fig. 2 and shows a violated correspondence between the exit from one process and the entrance to another process following it.

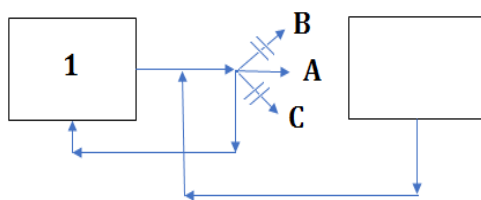


Fig. 2. Failed transition from one process to another

Moreover, the educational process is improved on the basis of feedback which compares and analyzes the result obtained with the quality of entry resources and the effectiveness of the educational process. When using the educational model shown in Figure 2, the reliability of the feedback raises doubts, which leads to a decrease in the quality of the educational process and an objective possibility of its adjustment with due regard to the requirements of the external environment (labor market needs, the competitiveness of young professionals and employers' requests). For example, a student who completed a Bachelor's degree in engineering does not have

the professional knowledge, competences, and skills to enroll in a Master's program in economics or sociology. For such a global change in a career trajectory, additional training is required to form a basic level (to replenish the knowledge that a Bachelor's degree provides), thereby ensuring the necessary knowledge and competences for obtaining a Master's degree in economics or sociology. Pre-learning to acquire the necessary knowledge in such situations is used by the leading Russian universities, including Lomonosov Moscow State University, Higher School of Economics, and Moscow Polytechnic University (Fig. 3). At the same time, a student who obtained a Bachelor's degree in engineering will have all the necessary knowledge to enroll in a Master's program in engineering or related areas of professional training (Fig. 1).

Currently, the requirements for professional knowledge and competences are dynamically changing along with the changes caused by the digitalization of society. Due to its natural conservatism, the educational process does not have time to completely rebuild and meet the needs of the labor market in a timely manner, including in engineering personnel. However, the digital environment has dualistic requirements for the educational process. On the one hand, the process of developing a young specialist should be meaningful yet fast (short-term) so that the knowledge and skills acquired do not lose their relevance in the labor market due to rapid changes. On the other hand, innovative digital technologies are based on the knowledge economy; therefore, knowledge, its depth, and coverage of professional activities and related fields form a competitive specialist in the market. In other words, the learning process becomes a long-term companion of any specialist who plans to remain in demand in the chosen professional field, develop and change together with it [17].

All these factors have adapted Russian education to a new model expressed by the formula "2 + 2 + 2". Its implementation involves the division of the Bachelor's degree into two stages: basic and specialized. This educational process has an obvious advantage. It has greater flexibility and adaptability to changes in the labor market and social demands for the educational process as a whole. It also contributes to more conscious professional self-determination and self-identification, which is very important for the realization of fundamental human rights and civil freedoms. However, an obvious problem in the implementation of this educational formula is getting into the situation depicted in Figure 2. In the case of the implementation of the educational formula "2 + 2 + 2", the problem may have a more negative social impact than in the above-mentioned mismatch of knowledge as a result of changing educational professional trajectories when moving from a Bachelor's degree to a Master's degree since a student after completing the first stage of education in the formula "2 + 2 + 2" does not have professional knowledge yet. Therefore, such a person does not have economic

independence or the basics of professional thinking and knowledge that are necessary for successful learning at the next level, which requires additional training and contributes to the beginning of professional adaptation (Fig. 3).

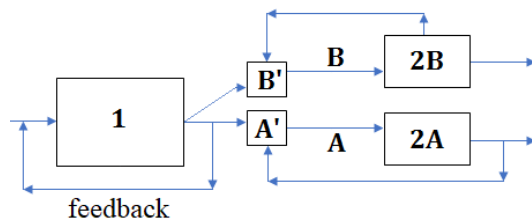


Fig. 3. The model of the modern educational process

For the constructive development of modern society, the continuity and effectiveness of the educational process are strategic goals that determine not only socially significant processes in general but also their direction and content since education is a social system designed to perform a complex function. This forms not only human resources of the required quality but also a certain type of personality, which is the key player in the political, economic, and social life of modern society [18].

4. Conclusion

The dominance of information and digital technologies that conditions the rapid pace and direction of developing all socially significant processes also causes the transformation and adaptation of the educational process in order to comply with social changes. However, any system has inertia, which to a certain extent performs the functions of self-preservation and ensures its stability and security. The current requirements for human resources are determined not so much by specific knowledge but by the ability to acquire it (i.e. one's ability to learn), as well as the ability to develop and be the carrier of the 21st-century competences, including socio-emotional, digital, cognitive, and soft skills. All these demands on the educational process highlight the relevance and importance of higher professional education for global processes in society. At the same time, the inertia of education performs a constructive function as it helps to select innovative (digital) technologies from the social perspective, as well as to support the transmission of academic knowledge and sociocultural experience, which contributes to the accumulation of intellectual and spiritual potential at the level of the national mentality. In case of the Russian education, it is determined by uniqueness but meets the actual needs of society.

Availability of Data and Material

Data can be made available by contacting the corresponding authors.

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