

Digital educational solutions as a factor of human capital formation

*Tatiana Kaloshina**, and *Dmitry Sichkarev*

Novosibirsk State Technical University, Novosibirsk, Russia

Abstract. Digital technologies provide unlimited access to information resources, contribute to the formation of skills in demand in the modern labor market. They also create new opportunities for entrepreneurship and business. All this is impossible without human participation. In this article we discuss the impact of digital educational technologies on the formation of human capital. In our opinion, digital educational technologies play a significant role in the development and growth of the individual, society and the economy as a whole. They make it possible to improve access to education, increase quality and efficiency, and adapt learning materials and methods to the individual needs of the learner. Digital education is becoming more and more popular every year, and new trends are emerging to shape its development.

1 Introduction

The problem of human capital formation has been relevant for a long time. The used category "human capital" was introduced into the practice of management in the latter half of the 20th century. The theory of human capital was developed by Nobel Prize winners T. Schultz (1979) [1] and G. Becker (1962) [2]. Speaking about the formation of human capital, it is worth saying that the concept itself is based on the theory of human investment and the theory of human capital production. For our study, the theory of investment in a person is of the greatest interest. According to this approach, investments in education are oriented to obtaining economic benefits in the future. This theory of human capital was supported by A. Smith [3], G. Becker [2], A. Marshall [4]. A. Smith defined human capital as "knowledge, skills and abilities" that are "owned by the worker" [3]. G. Becker argued: "human capital is everyone's stock of knowledge, skills, motivations" [2]. K.A. Erfrut considered human capital as "an accumulated, capitalized stock of personal qualities, the realization of which leads to the receipt of both economic and non-economic income in productive and non-productive life activity of a person" [5], which was formed by investment.

2 Materials and Methods

Undoubtedly, the formation of human capital is significantly influenced by many factors: researchers of this problem emphasize demography, political and socio-economic development, quality of education and health care, psycho-physiological, competence, socio-

*Corresponding author: kaloshinatu@mail.ru

cultural and technological factors [6, 7]. The group of competence factors includes knowledge, skills, experience, qualifications, competencies, while the group of technological factors includes digital ecosystems, big data analytics, and robotization. Digital Technology is a significant factor for instantly changing [8]. They create conditions for systematization and storage of information (text, images, sounds, animation) [9]. The use of communication infrastructure devices on the Internet, in terms of information accessibility, improves the quality of life [10] and the quality and effectiveness of learning [11]. This is clearly demonstrated by the concept of the Internet of Things.

According to official statistics in Russia in 2021, the domestic expenditures on the development of the digital economy from all sources amounted to 2.2% of GDP. Domestic costs of research and engineering in the priority line "Information and Telecommunication Systems" are as follows 7.7% of the total domestic expenditures on research and development, gross value added of the ICT sector – 3.2% of GDP. An important indicator is the number of publications of Russian authors in the field of ICT in the Scopus database – in 2021 their total number amounted to 17778 units (2.98% of the total number of world publications) [12 p.17]. The ICT sector employees in Russian companies increases annually (Fig. 1).

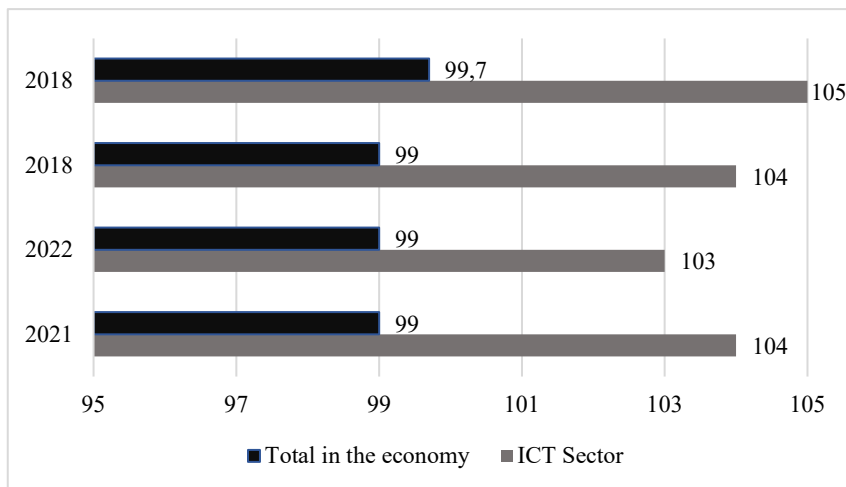


Fig. 1. Dynamics of the ICT sector employees in Russia (growth rate in % of the previous year) (developed by authors on the based on [12 p.72]).

Currently, when studying the formation of human capital, it is worth considering digital educational technologies, the development of which is influenced by the trends of the modern labor market. Under digital educational technologies we understand methods and education founded on scientific achievements and providing personal development and self-realization. One of the basic digital educational technologies are interactive electronic platforms and online courses. Their use allows learners to acquire knowledge and skills remotely, without visiting educational institutions, as well as to flexibly plan the time and pace of learning. In the program of online courses, authors usually offer interactive assignments, tests and games that make the learning process more fun and effective. Speaking about digital educational technologies, it is worth mentioning the use of artificial intelligence and data analytics. They make it possible to adapt educational programs and learning materials to the individual needs and knowledge level of each learner, as well as to automate assessment and feedback processes. Digitalization has penetrated all spheres of life and education. Modern educational methodology and practice are designed to address the challenges associated with the use of digital technologies [13].

Virtual reality (VR) and augmented reality (AR) are gaining popularity in the digital educational environment, where students can immerse themselves in virtual worlds and interact with different objects and situations. This creates more realistic and memorable learning experiences, labs, and other types of hands-on activities. The use of artificial intelligence and data analytics in the context of education helps in customizing educational programs. From the early 21st century, we can observe more and more precedents when these or those innovative solutions replaced a certain aspect of human participation in the production process. Digitalization has triggered the emergence of new industries – e-commerce, online education, cloud solutions, and so on. These industries are based entirely on digital technologies, and as a result, they require almost no physical human labor at all. These industries rely on intellectual human capital such as digital competencies, programming skills, digital-marketing and other related skills. It is safe to say that effective learning and mastering of the skills listed above is only possible with the active use of digital technologies. Since practicing the application of digital skills and competencies in practice and reinforcing theoretical material is possible only when appropriate digital environment. For example, programming skills and language skills require the ability to work in development environments, while promotion skills in e-commerce markets are only possible through practical examples and cases from the real economy.

3 Results and Discussions

Many authors agree on the importance of human capital formation with the help of technologies that provide digitalization of education. The labor market and education market are changing rapidly under the influence of digital technologies. The digital educational environment contributes to the formation of specific human capital, which is expressed as a set of knowledge, certain skills and competencies. All these knowledge, skills and competencies are in demand in a segment of specific jobs [14]. The development of the above components of human capital "is initiated mainly by the employer, as it increases the productivity of employees" of companies [15]. In this context, the training of specialists with the widest possible use of information and communication technologies (ICT) is of great importance. Specialists who must be able to work with large amounts of information and use modern software. The task of different levels of education is to master all the capabilities of digital technologies.

In today's increasingly digital and technology-oriented world, we propose the following algorithm for the formation of human capital (Fig. 2). Based on the identified needs and available human capital, the algorithm recommends educational programs that are aimed at the forming and developing digital competencies. After training, monitoring and evaluation are required. These include evaluating the performance of trained professionals and collecting feedback from employers and other stakeholders. Based on the results of monitoring and evaluation, the algorithm provides feedback and makes adjustments to the initial recommendations. Repeating the steps of the algorithm will enable informed decisions on human capital formation and provide a dynamic and responsive approach to meeting the changing needs of the labor market.

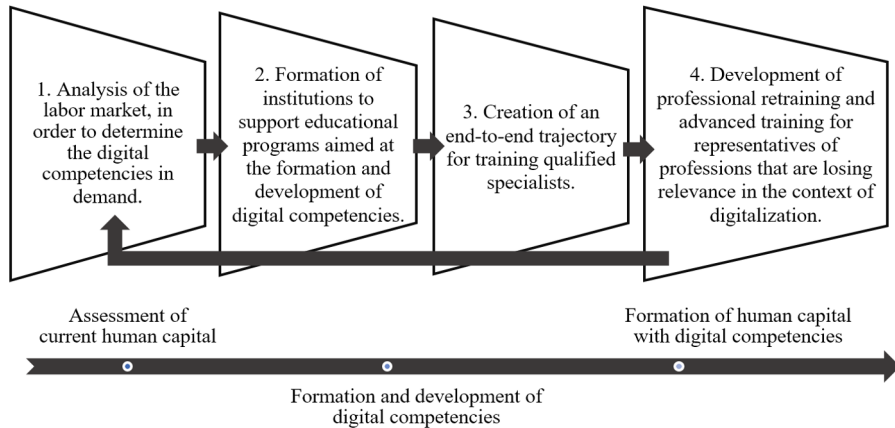


Fig. 2. Algorithm of human capital formation (developed by the authors).

The proposed algorithm will make it possible to level the growth of unemployment under the influence of changes in the labor market. In this matter, it is important to maintain the "seamlessness" of the educational trajectory in order not to create problems with professional orientation of specialists undergoing training. This will allow the formation of human capital with the necessary digital competencies to work in in-demand professions. Joint Information Systems Committee (JISC) defines digital competencies as "capabilities to live, learn and work in a digital society" [16].

Discussing the factors of human capital formation in the digital economy we talk about the need to take into account the features that fundamentally change the approach to the educational process (tab. 1).

Table 1. Approach to the education process in the digitalization (developed by the authors).

Factors of human capital formation	Approach to the education process
Compliance with the requirements of the modern labor market	Technological advances are changing business models and workflows in all industries, without exception. Employers are interested in specialists with digital skills, who are able to analyze data, work with new technologies and solve complex problems. Digital education provides the tools and knowledge necessary for a successful business career.
Global equity in education	Digital education removes geographical barriers and provides access to education for all, regardless of their location. This is especially important for students from remote or low-income areas who might previously have been left without the opportunity to receive a quality education. With online courses and distance learning platforms, students can learn anytime and anywhere.
Individualized approach to learning	Individualized learning plans and tailoring learning. The use of data analytics and artificial intelligence allows us to identify students' strengths and weaknesses, providing them with more effective learning methods. This individualized approach promotes better learning and increases student motivation.
Effective use of educational resources	Online courses and virtual textbooks can be easily updated and adapted to changing requirements and the latest knowledge. This reduces the cost of updating textbooks and the infrastructure of educational institutions, making education more accessible.
Learning process "outside the classroom"	Expanding the horizons of the learning process. Students can learn new topics and practice their skills outside of their institution. This allows them to independently explore areas of interest and develop critical thinking. In addition, online education allows working people to combine education with work and family life.

Resilience to future challenges	Digital education is an investment in the future. It prepares students to meet global challenges such as climate change, the development of artificial intelligence and revolutionary new medical discoveries. Trained professionals will be able to actively participate in creating innovations and solving global problems.
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It is also necessary to talk about the negative side of digitalization of education. Due to the rapid development of technology, there are more and more factors that potentially reduce the quality of human capital. For example, by using remote information transfer technologies (such as smartphones, headphones), students have easy access to the material during examinations of the learned material, which leads to incorrect assessment of the acquired competencies. In addition, artificial intelligence technologies and neural networks, which have been spreading in recent years, make it much easier for students to write large text works - term papers, theses, dissertations and scientific articles. Such technologies are becoming a kind of "intellectual prosthesis", replacing a significant part of students' efforts in the educational process.

However, one should not speak about artificial intelligence and neural networks exclusively in a negative aspect. In an era of rapid technological progress, neural networks are becoming one of the key innovative tools changing the face of many areas of human activity. In the field of education, neural networks are bringing revolutionary changes by creating new opportunities for the learning process and enriching the educational experience. One important aspect of applying neural networks in education is the individualization of learning. Neural networks make it possible to analyze learning data and create personalized learning plans for each learner. Based on data about each student's knowledge level, interests, and learning characteristics, neural networks can suggest the optimal learning path, accelerating and improving learning. The use of neural networks in education enables the creation of adaptive educational platforms. These platforms can be customized to the needs of each learner, offering tasks and materials that are most suitable for them. Thanks to neural networks trained on large amounts of data, the platforms can accurately assess the level of knowledge and offer tasks of appropriate complexity.

Neural networks are able to analyze the learning process and identify its effective and ineffective aspects. Data analysis allows optimizing teaching methods and improving the efficiency of the learning process. This includes optimizing curricula, identifying the most effective teaching methods, and refining instructional materials. In addition, the use of neural networks can enrich the educational experience of students. For example, neural networks can create interactive educational applications, simulations, and virtual labs. These innovative tools immerse students in the exciting world of learning, allowing them to experiment and learn interactively. The use of neural networks to assess learners' knowledge allows for a more objective assessment of their performance. Automated systems can process large amounts of work, analyze the content, and provide more accurate assessments. In addition, neural networks can provide feedback to help understand their mistakes and improve their skills.

4 Conclusions

As we can see, digital technologies make it possible to build an educational system as efficiently as possible in order to obtain a large number of highly qualified personnel with the necessary set of competencies to work in the specialties, the need for which is dictated by the new digital economy. In this context, the development of digital competencies becomes a key factor in the formation of human capital.

So, what are digital competencies? Digital competencies are a set of knowledge, skills and abilities necessary for the effective use of digital technologies. They include not only

basic computer and Internet skills, but also the ability to think critically, adapt to new technological changes and effectively solve problems using digital resources. Digital competencies are divided into several categories:

1. Information Literacy: This competency includes the ability to seek, evaluate, select and use information from various sources on the Internet. It is important for making informed decisions and avoiding misinformation.

2. Technology Literacy: This competency relates to the ability to operate various programs and applications, to understand the basic principles of computers and other devices, and to know basic technological terms.

3. Communication Literacy: This competency involves the ability to communicate effectively in online environments, including through email, social media, and video conferencing. It is important for both personal and professional communication.

4. Cybersecurity: Knowledge of basic rules and techniques for protecting one's information and devices from cyber threats.

5. Analytical Skills: Ability to analyze data and use digital tools to solve complex problems.

Why are digital competencies important? Digital competencies have become an integral part of modern life for several reasons: advances in technology, education, the need to combat cyber threats, and their convenience in everyday life. Technology is constantly changing and evolving, and in order to remain competitive in the job market and society, one must keep their digital skills up-to-date. Many training programs and jobs require people to know and be able to use digital tools. For example, programming is an increasingly in-demand skill. Digital technologies can greatly simplify our lives, making them more efficient and convenient. Knowing how to use them can help save time and resources. Also, when talking about the proliferation of digital technologies in the domestic environment, we cannot forget about dealing with cyber threats. Knowing about cybersecurity helps protect yourself and your data from potential threats.

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