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## Digital Technologies in the Development of Open Education

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### Abstract

In the context of the heritage of S.P. Kapitsa examined the role of human capital in the digitalization of socio-economic life, revealed the challenges of modern society, due to the development of the digital economy, presented a matrix of digital education opportunities. The basic requirements of the information society, aimed at creating a modern educational space, called the “Lifelong Learning Society”, are revealed. It is noted that the use of educational information networks as a platform for hosting various educational disciplines, the creation of a unified information educational environment is an important trend in the education of the 21st century, the so-called open education. Digital technologies are described, aimed at transforming many types of economic and social activities, including in the field of vocational education. It was emphasized that the pace and success of digital transformation is largely determined by the availability of qualified personnel with a high level of digital competencies. Attention is drawn to the fact that open education broadens access to new information and determines the personal choice of forms and content of instruction; allows interested and creative teachers to post authoring courses on educational platforms; in the system of open education, the public desire for knowledge is realized due to the fact that they are in free, unlimited access. An algorithm has been developed for the formation of an intelligent educational navigator, which allows, in terms of training personnel for the digital economy, to quickly adjust an individual educational trajectory in accordance with the formation of necessary competencies among students. Recommendations are given on calculating the economic efficiency of introducing an intellectual model for the formation of an individual educational trajectory.

*Keywords:* open education, information and communication technologies, individual educational path, digital educational resources, intellectual model.

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## **Introduction**

Digital technologies are transforming many types of economic and social activities, including education. The development of education at the present stage should meet the requirements of the information society, which is also called the “society of lifelong learning”. The development policy of domestic education is aimed at informatization of society, the implementation of information and communication technologies (ICT) in the educational process. The transformation of the information society into a knowledge society covers a large number of users, actively increasing the resource base.

## **Purpose and objectives of the study**

Purpose of this publication is to justify, develop and implement a model for the formation of an individual educational trajectory of a student in the form of a technological navigator that allows to quickly manage their educational and cognitive activities in terms of training for the digital economy and in accordance with the abilities, needs and level of personal and professional competencies formation.

## **Literature review**

Analysis of the literature on the issue showed that a number of authors emphasize the critical importance of the active implementation of the digital economy.

Thus, Babkin et al. (2017) highlights the development of digital culture as a key factor in digital transformation in the activities of market entities, and also justifies the need for technical normalization of the digital economy.

Varnavsky (2015) considers general approaches to assessing the impact of digital technology on global economic growth.

Gasanov & Gasanov (2017) consider information and communication technologies to be the main factor in the digital economy, and also reveals the mechanism of action of a quantum computer and its interaction with the digital economy.

In the work of Makrushin (2018) reveals the influence of new properties of economic goods of a digital nature on industrial and economic relations and social institutions.

## **Methodology**

A number of foreign authors, for example Shaabany et al. (2016) propose a new concept of the technological data market (TDMP), which allows you to process production data. The idea of the study is to develop a secure concept for the exchange of technological data between market participants, as well as to develop new business models based on existing resources that create a new stream of value creation in the industry. Sang

Sung (2017) provides a detailed hands-on discussion of Industry 4.0 and suggests policy transitions to Industry 4.0 in Korea.

A number of authors (Moustafa et al., 2018) see the uniqueness of Industry 4.0 in that it provides intelligent systems connected to the Internet, including automated organizations, on-demand development and “timely” development, including the integration of cyberphysical systems (CPS), InternetofThings (IoT), cloud and fog computing paradigms for the development of intelligent systems, smart homes and smart cities.

## **Results**

It is quite obvious that in order to move to a qualitatively new stage in the development of the Russian Federation, based on innovations in science, in which the non-material sphere becomes the most important factor in the competitiveness of the economy, knowledge has a special role to play as the main productive resource, which acts as the basis of the digital economy (Timirgaleeva & Grishin, 2016). Innovative ideas, supported by in-depth analysis and intellectually capacious developments, play an increasingly important role. This leads to the need for significant changes in the education system. It should be noted that publications have already appeared today that examine some aspects of human capital in the implementation of the digital economy. So, issues related to the formation of the knowledge economy and the role of human capital in its formation is considered. The problems of knowledge management in the knowledge economy, the modern labor market, the digital economy from the perspective of political economy, the educational environment as a factor in personality development, human capital assessment, engineering activity in the light of humanitarian culture, the need for the formation of moral capital, a philosophical approach to the study of the knowledge economy are highlighted (Timirgaleeva & Grishin, 2013; Semyachkov, 2017; Shaposhnik, 2017). In the context of the scientific heritage of Sergey Kapitsa (Kryukova, 2018), along with the general problems of the digital economy, examines the role of human capital in the digitalization of social and economic life, reveals new challenges to modern society due to the

development of digital education. Scientists note that the traditional underestimation of the need for investments in the development of human capital, traditional for Russian managers, seems short-sighted, since there is a large gap between the performance of enterprises in the Russian Federation and the EU in terms of the level of employee involvement in training for the purpose of mastering ICT. The pace and success of digital transformation is largely determined by the level of digital and related competencies of the population, the availability of qualified personnel, and scientific potential.

Thus, a number of issues remain unresolved, among which the need to create an intellectual model for the formation of an individual educational trajectory in the form of an educational navigator, which, in its turn, is formed on the basis of the requirements of educational and professional standards might be specially defined, as well as taking into account the current requirements of the branch.

### **Discussions**

One of the federal projects of the National Program “Digital Economy of the Russian Federation” (24.12.2018) includes the program “Personnel for the Digital Economy” (Ministry for Digital Development, Communications and Mass Media, 2019). The target of the project is, first of all, to improve the education system in the direction of providing the digital economy with competent personnel. The solution of this problem allows to form personnel that meet the requirements of professional standards of the digital economy professions according to the conditions of labor market transformation, as well as to create a motivation system for developing the necessary competencies and staff participation in the development of the digital economy of the Russian Federation. The implementation of this project is scheduled for 2019-2024. At the same time, by 2024 it is planned to achieve a number of indicators, some of which are presented in table 1.

Table 1

Success indicators of the implementation of the federal project “Personnel for the Digital Economy” of the National Program “Digital Economy of the Russian Federation” by 2024

Indicator	Account
The number of graduates of higher educational establishments in areas of training related to information and telecommunication technologies, one thousand people	120,00
The number of graduates of higher and secondary professional education establishments with competences in the field of information technology at the global average level, one thousand people	800,00
The proportion of the population with digital skills,%	40,00
Number of specialists retrained in the competencies of the digital economy as part of supplementary education, one thousand people	1 000,00
Place in the Global Talent Competitiveness Index talent ranking, place	30
The share in the All-Russian verification work of tasks during the implementation of which the use of digital resources (tools, sources, environments, services) of professional or everyday activities is allowed,%	100,00

To implement these indicators for the implementation of the project “Personnel for the Digital Economy” (Ministry for Digital Development, Communications and Mass Media, 2019), Russia has already launched an online service to improve digital literacy, the main purpose of which is free training in the safe and efficient use of digital technologies and services. Besides, informatization and digitalization offers resources that allow getting education regardless of location. Creating a virtual educational environment for learners and trainees is already becoming widespread. Educational information networks, on the sites of which methodological and informational materials, innovative developments and other educational and

methodological materials are posted. These resources provide an opportunity to receive online education, as well as improve your professional level.

The most popular educational information networks in Russia are such online educational resources as the Internet Education Federation portal, the Russian educational telecommunications network REDLINE, the network of creative teachers, the network of methodologists Uchitel.ru”, Russian educational portal and others. These and other networks span a growing number of learners and learners, creating virtual communities and an extensive digital educational environment in which teaching materials are accumulated and distributed. These resources provide an opportunity to exchange experiences, gain additional knowledge, work as a team, while acquiring digital literacy skills, learning how to use information and communication technologies not only for training, but also in various life situations.

It is appropriate to remark, that the use of educational information networks as platforms for hosting various educational disciplines, the creation of a unified information educational environment is an important component of the digital transformation of education and an important development trend in the education of the 21st century, the so-called open education. It is worth mentioning, that the development of the educational system in contemporary conditions is implemented on the basis of the paradigm of advanced education, the tool of which is open education technology. The main advantage of this system is the ability of each student to build such an educational trajectory that most fully meets his educational abilities and professional needs.

Open education, which in its essence is mass education, including mass open online courses (MOOLC), is recognized as one of the most influential innovative approaches to education, along with such as “inverted learning”, data collection and its use in training, “The goal is training”, the BYOD principle, dynamic assessment, event education, storytelling in education, the concept of thresholds, bricolage. It is the massive open online courses that top the wide range of innovative approaches to education, which is caused by the increased understanding of society of the need for constant replenishment of knowledge, which form the basis for the development of both an individual and society as a whole (Sharples et al., 2014).

This idea was fully formulated by Wikipedia founder Jimmy Donald Wales (Wales, 2011), who created the first on-line wiki encyclopedia, where he realized the goal that “... every person on the planet has free access to the entire amount of human knowledge ...”. Another important advantage of open education is that it is accessible to anyone who wants to get an education. It does not require a preliminary analysis of the input level of knowledge. In addition, this training system uses distance learning technologies and techniques that provide training in the mode that the student chooses for himself.

The principles of open education presuppose providing students with a wide choice of opportunities within the framework of various aspects of the educational process – choosing the place and time of training, the content of educational programs, their intensity, methods. The advantage of open education is the ability to obtain multimedia materials, as well as an objective assessment of knowledge.

Speaking about open education, several aspects are to be taken into account.

Firstly, open education is implemented on the basis of distance learning technologies. However, these concepts are not synonymous, because distance learning allows you to study without visiting the school, but with regular consultations with teachers of the school. As for open education, this is, in essence, the expansion of accessibility and personal choice in the learning process, and distance learning is a way of transferring knowledge.

Secondly, open education allows interested and creative teachers to post copyright courses on educational platforms.

Thirdly, there are no boundaries for open education. The main condition is to be able to live in an informational, digital society and competently use all its capabilities.

Fourth, the public desire for knowledge is realized for the reason that the access to them is free and unlimited. The ability to obtain this knowledge does not depend on the social status of the individual, their location, financial state and previous experience, including learning experience. Due to the stated above, societies of people interested in training are created, and networked collective training is formed.

However, the problems and risks that accompany the concept of open digital education should be identified.

The main ones are listed below.

First, information technologies solve many problems in the field of education, but they do not solve the problem of filling educational resources with proper content. Software developers offer good solutions filled with multimedia and animation, but they are not familiar with the training program. On the other hand, the teachers themselves are not involved in the development of software products, there is no methodological support. Therefore, the effective implementation of ICTs cannot be achieved without the active participation of teachers themselves in the development of digital content.

To solve the indicated problem, it is necessary for the electronic course to be created in collaboration with the teacher and the software product developer. The teacher does not require a high level of ICT

knowledge, as far as the crucial feature here are both their qualification as the course author in the subject area and their ability as a teacher and methodologist. The task of a teacher is to study the capabilities of modern ICT, paying particular attention to audio and video clips, methods of visualizing formulas, graphs, figures, tables and other elements of support for training courses. As for the content developer, they should be competent in matters of technical implementation and support of the digital product, which should be a joint work of a teacher and an ICT specialist, inclined to allow timely correction of all previous fragments of work and to bring the training course to the required level.

Secondly, nowadays-online education is offered not only by educational institutions, but also by Internet sites that offer mass open online courses (MOOLC) and individual online disciplines, which are not always interwoven. Besides, such courses might not provide a certain specialization; they might be completed in a certain number of hours by completing a certain number of tasks and listening to lectures. Similar courses are offered by MOOLC portals, which are focused on obtaining a commercial or social result. MOOLC compete with higher education institutions as long as they promptly place the required courses, which are rapidly developing and their audience is growing exponentially. As for the classical universities, they are developing online education not so vigorously.

An important component of open education is the digital educational resources (DER), several stages of their creation have to be followed:

- establishing compliance of the presented content with the core content of the work program for a specific discipline;
- determination of relevance as well as scientific and technical level of the educational content;
- didactic elaboration and structured content of the material based on a modular competency approach;
- compliance with the ergonomic requirements for the DER (visual presentation of the material on the screen, design, selection of scales, fonts, animations, etc.);
- providing multilayer (multi-level) presentation of educational material, taking into account the applied hypertext links.

When creating the DER, it is necessary to take into account not only the age, but also the psychological characteristics of the students. It is important to use the capabilities of the university information system

software when developing a specific type of DER. Special attention should be paid to the question of the correspondence of the content and structure of the special education center to the specific type of electronic educational-methodical complex of discipline (EMCD) - an electronic textbook, study guide, lecture notes, workshop, tests, cases. It is also required to ensure that the content of the materials of the center is consistent with the type of training in a particular discipline - a lecture, a workshop, laboratory work, independent work, etc.

Thus, we are approaching the need to create an intellectual model for the formation of an individual educational trajectory in the form of an educational navigator, the formation of which is based on compliance with the educational and professional standards, as well as taking into account the current requirements of the industry. The starting points for the formation of the list of necessary competencies are professional and educational standards, as well as the current requirements of the industry for the job functions.

Based on these requirements, a list of relevant competencies, supposed to be obtained by a graduate of a designed educational program, is formed. Then, a curriculum that meets the requirements for the formation of a given level of competencies in the form of an individual educational path, which can be adjusted taking into account the assessment of the level of competencies achieved by specific students, is created.

The proposed intelligent navigator might be implemented using artificial neural network technologies on stationary computers or mobile devices with the necessary computing characteristics.

Certainly, any project requires an assessment of effectiveness and efficiency. First of all, we consider it necessary to determine the performance and performance criteria. As the main criterion for the economic efficiency of introducing an intellectual model for the formation of an individual educational path, we will take an indicator that reflects the impact of digitalization on the effectiveness of the functioning of an individual educational navigator (IEN). As such a criterion, we regard the ratio of the costs of the formation of an individual educational trajectory (IET) to the total cost of digitalization means (DM):

$$\Xi_{O\Omega} = \Xi_{\text{ИОТ}} / C_{\text{Ц}}$$

It is worth mentioning, that the practical application of this criterion presents a certain complexity, since it is impossible to take into account the entire degree of influence of various conditions and factors on the efficiency of the functioning of the IET. Currently it is not possible to find proper coefficients for commensurability of fundamentally different elements of the chain of formation of an individual educational trajectory and take into account the whole variety of environmental factors and features of each

individual person. In further studies, from the point of view of the development of methodological aspects of this issue, we set ourselves the purpose to find such coefficients. At this stage of the study, as a general criterion for the effectiveness of the functioning of the ION, we consider it logical to accept its ability to provide minimal costs when changing conditions within which an individual educational path will be formed. This will allow us to conclude how IET will provide a solution to one of the important tasks of modern education, which is to form the required competencies in accordance with professional and educational standards, as well as the current requirements of the industry to perform labor functions in a given time with minimal costs and thereby obtain the desired effect. We propose to determine the quantitative value of this criterion as a function of the time taken to organize the formation of an individual educational trajectory (TIOT) and the time for the implementation of this process, defined by the conditions (TC):

$$\Phi_y = F(T_{\text{ИОТ}}, T_y)$$

As local criteria for characterizing individual aspects of the digitalization efficiency of the individual educational trajectory forming process, we single out the criteria for sustainability, stability, reliability, responsiveness, flexibility, accuracy, and mobility of functioning of the educational system formed.

According to the authors, the criterion of mobility of the digital control system, within which an individual educational trajectory is formed, is important. Mobility is one of the most important conditions for ensuring the sustainability and continuity of this process. The main criterion for mobility is the ability of subjects to control the process of formation of an individual educational trajectory – to receive information, process it, make appropriate decisions as well as timely and fully bring them to the control object (individual educational trajectory of a student). An important criterion is flexibility. Assessing this criterion, it is necessary to determine the ability of the system for the formation of an individual educational path to ensure a change in an individual educational path depending on changes in professional and educational standards and industry requirements. In addition, it is advisable to take into account the ability of the system to solve new, additional tasks. As the main indicator of flexibility, we suggest using the time required to adapt the digital system.

Another task is to determine the indicators of technical efficiency of the digital system for the formation of an individual educational trajectory. This assessment consists in determining the technical capabilities and the degree of system perfection, the convenience of working with digital equipment in various conditions of its use. However, the assessment of technical efficiency should be linked to the assessment of economic efficiency. The perfection and rationality of technical solutions must be evaluated taking into account the

economic costs of their implementation. Special attention must be paid to the calculation of capital and operating costs for the maintenance of the system. This should also include the costs of research, development work, the preparation of tasks, programs and other measures for mathematical support, the purchase or rental of a digital system from the beginning of its operation (the cost of maintaining staff, repairs, the purchase of operational materials, software products). Besides the criteria stated above, other criteria might be used that reflect the specifics of the functioning of various elements of the digital system of an individual educational trajectory.

## Conclusion

The current stage of higher education is characterized by a significant influence of digitalization processes on it. A new worldwide development trend, which has replaced the processes of informatization and computerization, allows us to offer an intelligent navigator, using artificial neural network technologies on stationary computers or mobile devices with the necessary computing characteristics. The implementation of the proposed model is aimed at ensuring high pedagogical effectiveness of training for the digital economy, which allows quick response to the needs of industries based on the active use of open education information technologies.

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