Trends and perspectives of using blockchain technology in the digital transformation of the education system

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Abstract — The digital transformation of the education system, due to modern conditions for the development of socio-economic relations and information and communication technologies, involves a radical modernization of its information technology landscape through integration with end-to-end digital technologies. The main directions of the development of global integration processes in the field of education include the creation of a single educational space and the optimization of the interaction of participants in educational relations and stakeholders. One of the most promising technologies for solving these problems is blockchain technology. Harmonization of the conceptual principles of this technology and the existing educational infrastructure will provide a qualitatively new level of interaction based on information transparency, security and mutual trust and will serve as a driver for aggregating scientific and educational content and data on individual achievements of students on a single platform. The potential capabilities of the technology, on the one hand, and the insufficient level of research on the integration problem, along with the lack of blockchain projects implemented in the educational sector, on the other hand, determine the relevance of studying systematic applications of blockchain technology in various fields of education and preventing the uncertainties and risks.

Keywords — digital technology, blockchain technology, digital transformation, education system, single digital educational space, integration strategy

I. INTRODUCTION

The rapid transformations taking place under the influence of the globalization of socio-economic relations and changes in the information technology landscape put forward new requirements for education as an intangible investment asset, characterized by a shift in strategic priorities in investing in the development of human capital. Unlike the commodity economy, the currently developing knowledge economy gives priority to the growth of intellectual capital and the continuous development of competencies necessary for effective professional and everyday activities in the digital environment. This determines the desire of the state to stimulate the development of innovative infrastructure of the education system as a system that forms the most important state strategic resource: high-quality human capital. The transformation should be based on the digital transformation of the existing education system, which involves the construction of digital infrastructures, the formation of digital educational assets and their convergence with traditional ones based on integration with end-to-end digital technologies. The conceptual foundations and principles on which blockchain technology is based, on the one hand, provide ample opportunities for creating a single digital educational space, and on the other hand, are the subject of controversy among researchers in the IT and education sectors. Now the theoretical and methodological elaboration of this problem is insufficient for its practical implementation, and therefore, in order to develop a balanced strategy for introducing blockchain technology into the education system, it is necessary to conduct comprehensive studies to identify potential applications, identify benefits and risks of implementation.

II. RESEARCH METHODOLOGY

The process of forming a single digital educational space requires the creation of an information technology infrastructure based on the integration of the existing education system and breakthrough digital technologies. The formation of digital scientific and educational content, the creation of a single database of individual achievements of students (blockchain passports) necessitates the analysis and systematization of large volumes of heterogeneous information. The multi-level structure of the education system, the various forms of its receipt, the age-wide coverage of various categories of the population within the framework of the concept of lifelong learning throughout life, on the one hand, and the multivariance and insufficient study of the possibilities of using blockchain technology and the risks of its implementation, on the other hand, necessitate conducting integrated research based on a systematic approach. In order to
formulate a balanced integration strategy, determine the advantages and disadvantages of implementing blockchain technology in the education system, the following were carried out:

- a retrospective analysis of the evolution of information and communication technologies in the context of determining the current state and development direction [1];
- theoretical and methodological study of the conceptual foundations of distributed ledger technology [2, 3];
- critical analysis of potential educational areas for the prospective implementation of blockchain technology and pilot blockchain projects [4, 5, 6, 7, 8].

A retrospective analysis of the evolution of information and communication technologies indicates that its current state is characterized by a change in the direction of the development vector from technical and technological support of production and socio-economic processes to creating a strategic advantage in the economy and social sphere. The priority areas of research are breakthrough digital technologies relevant in the formation of the ecosystem of the digital economy, not only from the standpoint of identifying their methodological foundations and technical aspects, but also from the point of view of identifying the main areas and prospects of using both the technology as a whole and a specific technological solution.

Based on the analysis of the results of research of blockchain technology by domestic and foreign scientists, presented in periodical and special literature, Internet resources, scientometric databases (RSCI, SCOPUS, Web of Science) in the form of scientific articles, reports, theses of scientific and practical conferences, were highlighted their main directions:

- theoretical and methodological foundations of blockchain technology [9, 10];
- technological aspects of the development of the blockchain platform [11, 12, 13];
- regulatory support and the specifics of financial transactions using distributed ledger technology [14, 15, 16, 17];
- Features and perspectives of introducing technology into various fields of activity [18, 19, 20, 21, 22, 23, 24, 25 etc.].

The studies noted the high efficiency of the use of blockchain technology in systems requiring complete data synchronisation, a high degree of information security and authorship of the performed actions. According to experts, in the near future, blockchain technology will become a driver of digital transformation not only of the financial system. Currently, an active process of its development and implementation in the field of public administration, insurance, healthcare is being carried out, models of using technology to create a supply chain ecosystem, etc. are being proposed. There are a number of research projects affecting various aspects of the use of blockchain technology to solve the digitalization of the education system and the formation of global educational space. As a rule, the works are general and theoretical in nature and are devoted to certain issues of the digital transformation of education using blockchain technology, such as: problems and perspectives of issuing digital academic diplomas and certificates [26, 27, 28], standardization of education certificates [29], validation of certificates and candidate certificates for their compliance with the required competencies [30, 31, 32], description of blockchain projects in the field education, for example:

- Teachur for using technology at various levels of the education system: general (building an innovative system for assessing the level of knowledge of schoolchildren and the degree of achievement of goals), higher (accounting for the learning process, smart contracts for obtaining a diploma, platform tokens to stimulate the educational and methodical work of teachers, etc.) [33];
- Sony Global Education service for storing reliable individual data on the student’s education and the formation of a complete history of his studies [34, 35].

Thus, the review of bibliographic sources indicates the fragmentation of the ongoing scientific research on the problem of using the technology of distributed registries in education, the need to systematize the accumulated information and continue research using a systematic approach.

III. RESULTS OF THE RESEARCH

The digital transformation of the education system, which forms the basis of the dynamic economic growth and social development of society, is defined as one of the priority directions of the state policy of the Russian Federation and is a prerequisite for the formation of the ecosystem of the digital economy of Russia. The development of global integration processes puts forward new requirements and creates the conditions for the formation of a single digital educational space. Full consistent digitalization of Russian education will become a platform for a qualitative change in its institutional, information and technological infrastructure and will allow Russia to claim a leading role in the global educational space. Modernization of the education system based on the use of innovative digital technologies will open up new opportunities for the formation of high-quality human capital, the implementation of the concept of lifelong learning throughout life, provide new formats and tools for the formation of digital competencies, individual educational paths, continuous improvement of the qualification level, acquisition of safe and effective skills the use of digital technology in professional activities and in everyday life for a comfortable life in the interactive space of the ecosystem of the digital economy.

To create an effective environment for interaction between participants in educational activities and interested parties, it is necessary not only to create and use information systems that comply with modern requirements, but also to introduce end-to-end information technologies, which allow a qualitatively
new level of development of national and regional educational systems within a single educational space. One of the most promising digital technologies, considered as the driving force of the digital transformation of education, the potential of which is able to provide the possibility of creating a single educational information space, is blockchain technology.

Distributed ledger technology as a fundamentally new way of storing information on the basis of a decentralized distributed database in combination with its conceptual principles of transparency, openness, security, etc., the ability to create flexible multifunctional platforms on its basis provide its clear advantages over other technologies when developing an efficient collection infrastructure, storage and processing of educational data, development of a management system for assessing the quality of education, improving and monitoring mechanisms, etc.

The integration of blockchain technology into the existing educational system involves the search for optimal mechanisms and the formation of a balanced strategy based on the analysis of possible options for harmonizing existing traditional models in the education system and the functional features of blockchain technology. In the framework of this study, the main directions of introducing blockchain technology into the continuing education system are identified and systematized (Fig. 1).

The prospects and potential opportunities for introducing blockchain technology in the educational sphere are currently quite difficult to fully assess, since the blockchain industry, despite a ten-year path of transformational development from cryptocurrency to services and platforms that can solve specific problems in a particular sector of the economy, is at the initial stage of evolution. However, in the process of studying the problem under consideration, the authors identified four groups of the most significant advantages of using this technology for digitalization of the education system:

1. Simplification of the interaction of educational participants and stakeholders
   - transition to the digitized format of documentary support for the educational process and the interaction of its participants with each other and with interested parties in the form of smart contracts;
   - the possibility of forming a digital individual educational trajectory - a blockchain passport that records information on student achievements at all levels of formal, non-formal and informal education in the register as part of the concept of lifelong learning throughout life;
   - continuous real-time access to information on a student’s blockchain passport about individual achievements of a student, which allows participants in educational relations to analyze and evaluate the formation of competencies on the basis of a digital footprint when moving from one educational level to another, and employers to assess the availability of practical (including specific) skills in the selection of specialists;
   - the possibility of practical implementation of the idea of virtual academic mobility of students;
   - reduction in the number of intermediaries and the number of approvals in confirming the validity of certificates, diplomas and certificates.

2. Reduction in transaction costs and other costs of educational participants and stakeholders
   - reduction of budgetary and extra-budgetary funds for consumables due to the rejection of paper workflow;
Fig. 1 Digital transformation of a continuing education system based on blockchain technology

- Reducing the financial burden of educational institutions on staffing, as the process of recording information in a chain of blocks does not require the participation of specialists;
- cost optimization due to changes in the financial interaction infrastructure by creating a blockchain environment for financial transactions of the state, educational institutions and other participants in
educational relations by reducing the number of intermediaries and intermediary operations.

3. Ensuring transparency and security of interaction between educational participants and stakeholders

- transparency of data exchange, accessibility and promptness of obtaining complete and reliable information about the individual achievements of the student and the level of formation of his competencies for all interested parties who are registered users of the blockchain network;
- simultaneous updating of information at all educational and labor parties in real time;
- ensuring high reliability of the information storage system through decentralization and distribution of the network, as well as a qualitatively new level of its protection through the use of cryptography and the impossibility of making changes to the blockchain without the approval of all participants in the blockchain network, which eliminates the falsification and falsification of education documents (certificates, diplomas, certificates, etc.);
- operational tracking and blocking of fraudulent operations with transactions, prevention of doubtful providing data any of the parties;

4. Improving the mutual trust of participants in educational activities and stakeholders, the possibility of analysis and forecasting

- increasing confidence in academic data — the components of a blockchain passport, since obtaining a diploma is essentially a smart contract, which is an automatic confirmation of academic achievements and the formation of competencies;
- a single database with confirmed knowledge and skills will create an open market for candidates and carry out their dynamic selection based on an independent assessment of qualifications, based on a set of skills and required skills;
- analysis of the demand for certain competencies will make it possible to create a personnel forecasting system, to quickly update the content of educational programs aimed at creating demanded competencies in the dynamically changing ecosystem of the digital economy.

The development of the blockchain industry is currently facing a number of internal and external constraints that are causing debate. Projects for the implementation of blockchain technology are, as a rule, pilot in nature, which is due to a number of reasons related to the complexity and global nature of the problems involved, the illegitimacy of the operations performed in the system, the lack of domestic technological solutions, and official and public recognition. In this regard, identification of the problems of introducing blockchain technology into the education system is relevant:

- methodological: the need to adapt the conceptual foundations of blockchain technology to the characteristics of the educational system and develop a balanced strategy for their integration;
- technical and technological problems: the lack of a national blockchain platform, the need for technological harmonization of domestic blockchain developments with foreign ones, the limited scalability and bandwidth of the network, the need to modernize the information technology infrastructure due to insufficient computing power of existing devices to perform high-level encryption algorithms;
- legal: the lack of a regulatory framework governing the use of blockchain technology in the educational field, regulations for the legal recognition of new categories (digital diplomas and certificates), the need for unification and standardization of documents confirming individual achievements;
- organizational: the lack of a centralized management structure that coordinates the blockchain environment as a single digital educational space, the lack of qualified specialists, the need for staff retraining;
- financial: the high cost of developing and implementing blockchain projects due to their scale, along with the low level of funding for the education system, as well as the high costs of adaptation, initial setup and maintenance (upgrading hardware, high power consumption, etc.);
- psychological: the immaturity of blockchain technology, the stereotype of the synonymy of blockchain and cryptocurrency, associations with the possibilities of using it only for financial transactions, the insufficient number of implemented projects and skepticism regarding its use in education.

Thus, many aspects of the ecosystem of blockchain technology require further study and research aimed not only at finding new possibilities for its use, but also at reducing the risks of implementation.

IV. DISCUSSION OF RESULTS

A retrospective analysis of the evolution of blockchain technology, a study of its conceptual foundations and principles, an analysis of the practical implementation of blockchain projects in various sectors of the economy allow us to conclude that the technology has a high functional potential, rapidly expanding its fields of application, and gradually institutionalizing it in the socio-economic relations of modern society.

The conservative nature of the education system often hinders the introduction of innovative technologies in educational structures and processes. However, in modern conditions of the formation of the ecosystem of the digital economy, its digital transformation is becoming an inevitable process. The advantages provided by the use of digital technologies in the educational sphere, the dynamism of the technological landscape make it necessary to conduct research
on the search for models and mechanisms for their integration. Currently, studies of the potential of blockchain technology in education are fragmented and reflect only selected aspects of this problem.

For a comprehensive solution to the problem of creating optimal conditions and a technological environment for the realization of its potential capabilities, a system analysis was carried out within the framework of the study and promising areas for introducing blockchain technology into the educational environment were identified: the implementation of the paradigm of lifelong learning, a conceptual change in the system of storing information about the individual achievements of the student, the creation of a single platform for the interaction of participants in educational activities and stakeholders, the formation of a single database of scientific knowledge and an effective system for depositing and fixing copyright, optimizing the financial system of educational organizations.

The advantages of using this technology to digitalize the education system are identified and structured, problems of methodological, technical, technological, legal, organizational, financial and psychological nature that impede the practical implementation of blockchain projects in this area are highlighted.

V. CONCLUSIONS (INERENCE)

The results obtained during the study, confirming the high potential of blockchain technology for solving the problems of digital transformation of the education system, can be used as the basis for further research on the development of alternative options and the formation on their basis of a balanced strategy for integrating distributed ledger technology into the educational environment.

References


