Modern American Journal of Business, Economics, and Entrepreneurship
ISSN (E): 3067-7203
Volume 01, Issue 02, May, 2025
Website: usajournals.org

EVALUATION OF THE EFFECTIVENESS OF BLOCKCHAIN TECHNOLOGIES IN THE HIGHER EDUCATION SYSTEM

Anvarova Mukaddas Makhamadjonovna
Senior Lecturer of the Department of "Digital Economy" of TSUE
m.anvarova@tsue.uz

Khusniddinov Yorqinjon Muhiddin o'g'li
Assistant of the Department of Digital Economy of TSUE
khusniddinov24@gmail.com

Abstract
This article analyzes the implementation of blockchain technologies in the higher education system and evaluates their effectiveness. It highlights how blockchain ensures data security, transparency, and reliability in educational processes. In addition, the article examines international practices and the current situation in the national context, using statistical data to assess the changes observed in institutions where blockchain has been implemented. Special attention is given to identifying the role of blockchain in education, current challenges, and emerging opportunities.

Keywords: Blockchain, higher education, digital technology, data security, education quality assessment.

Enter

Globally, great attention is being paid to improving the quality of education, protecting data, and making the system more transparent by introducing digital technologies into the education sector.[1] Blockchain technology is emerging as an important innovative solution for the education sector. This technology allows data to be stored in a decentralized, non-editable and highly secure manner.[2]

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Preventing the forgery of diplomas and transcripts in higher education institutions, protecting student data, and ensuring reliable electronic document circulation can be effectively achieved through blockchain.

In his speech at the forum on the topic "Training a new generation of personnel a national priority" in September 2024, the President of the Republic of Uzbekistan Shavkat Mirziyoyev also emphasized that "it is necessary to introduce digital solutions at all stages of education, especially in higher education, and to transform electronic certification and data management through blockchain into effective mechanisms."

Blockchain technology serves not only to store data, but also to strengthen the atmosphere of trust between participants in the educational process.[3] This will take relationships between students, teachers, and administration to a new level. In addition, blockchain can also simplify the process of data exchange and recognition in accordance with international educational standards. [4] The main goal of this article is to systematically analyze the place of this technology, to determine its level of efficiency, and to show the problems and solutions that arise during its implementation.

Literature Review

In recent years, especially after 2020, blockchain technology has become an important innovation in the field of education. The efficiency, security, and transparency of data storage and automation through blockchain are among the most important advantages.

Zhou, Y., Wang, F., & Chen, L., in their scientific article on the potential of blockchain technology in education, argue that blockchain technology can ensure the immutability and accuracy of data. This will facilitate the exchange of data between educational institutions and create the opportunity to directly verify students' academic results. [1].

A study on academic data management conducted by Turkanovic, M., Hölbl, M., Kosic, K., Heričko, M., & Kamišalić, A. shows that the blockchain-based EduCTX platform can store students' academic data in a secure and decentralized manner and make them internationally recognized. This platform

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makes it easy to verify the educational results of the students and provide them with valid certificates [2].

Wang, Q., Li, R., & Sun, J., in their research on automation through smart contracts, demonstrated the potential of blockchain technology to automate the educational process through the use of "smart contracts.". This technology makes it possible to automatically calculate scholarships, grades and educational results in the system, which reduces the human factor and speeds up the system [3].

In their research on practice and analysis in Uzbekistan, Kurbanov, D. and Rakhmonov, J. examined the prospects for introducing blockchain technology in the higher education system in Uzbekistan. They mainly emphasized the importance of technical and legal aspects, as well as adaptation to international experience. The authors analyzed the legal and economic factors of implementing blockchain in educational institutions in the country[4].

Kumar, N. and Tripathi, R., in their research on the impact of blockchain on efficiency, found that the use of blockchain technology in the education sector can increase the efficiency of data processing systems, ensure security, and reduce the human factor. They evaluated the level of use of blockchain in terms of reliable recording and its economic efficiency. [5].

In their scientific article titled Challenges and Prospects, Bozkurt, A., Karadeniz, A., & Alper, A. analyzed the challenges and prospects of blockchain implementation in education. They identified technical infrastructure, legal guarantees, and human resource training as complicating factors for implementing blockchain in the education system. They also noted that the full implementation of blockchain requires clear directions and strategies [6].

Methodology

This research paper aims to assess the effectiveness of modern blockchain technology in the higher education system. It identifies the importance of blockchain in ensuring data security, transparency, and reliability, and demonstrates its effectiveness through international experience and analysis in Uzbekistan.

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Analysis and Results

The implementation of blockchain technology in the higher education system shows that it has a certain degree of effectiveness. [16] In particular, blockchain has advantages over traditional methods in ensuring data security and document authenticity. The majority of students and teachers expressed confidence in blockchain-based systems and noted that this technology had a positive impact on the educational process. [17] According to the results of the survey, in higher education institutions where blockchain was implemented as a trial, the document verification process was accelerated, human factor errors were reduced, and electronic information circulation was improved. This has increased transparency and accountability in the system. At the same time, the ability to access data online and quickly has served to increase efficiency in the educational process. [18] But some problems were also revealed during the research. In particular, lack of personnel, weak technical infrastructure and limited financial resources were noted as one of the main obstacles in the process of introducing blockchain. In addition, some participants were excluded from full use due to a lack of sufficient information about the nature and benefits of the technology. [19] Based on the recommendations of international organizations such as UNESCO and OECD, it was determined that the development of institutional strategies, staff training, and the creation of a legal framework are of great importance in the implementation of blockchain. On this basis, the following conclusions can be drawn for the effective implementation of blockchain technologies in the education system of Uzbekistan:

Blockchain technology is highly effective in providing information security, transparency and reliability in education;

✓ Development of human resources and technical infrastructure is important in the implementation process;

✓ National legal and institutional framework needs to be adapted for blockchain;

✓ The full use of technology can be achieved by improving digital literacy in learning participants.

The study can also serve as a foundation for future research. By conducting comparative analyses with the implementation of blockchain technology in areas

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outside of education (e.g., healthcare, human resources management), it will be possible to assess its broader impact.

Table 1 below is based on the results of a survey conducted to assess the effectiveness of blockchain technology in higher education. This survey was conducted at 5 higher education institutions including TDIU, UzMU, TATU, TDPU and TDTU universities where blockchain technology was introduced, and the results were collected based on the opinions of students, teachers and administration. The table contains the following information:

Table 1 Results of a survey on the effectiveness of blockchain technology in the higher education system [1]

Category	Satisfaction level (%)	Performance indicators
Students	82	Information security, authenticity of documents
Teachers	76	Automating the educational process, reducing bureaucracy
Administration	80	Data verification, statistical analysis
International experience	90	Increasing the quality of education, diversity of diplomas

✓ Student Satisfaction Level Students expressed satisfaction with information security and document authenticity through blockchain technology. They recognized the important role of blockchain in the educational process and noted that they have increased confidence in the security of documents.

✓ Teacher satisfaction level, teachers considered the blockchain system as an important tool for automating the educational process and reducing bureaucracy. They noted that blockchain technology has enabled them to ensure transparency and accountability in their work.

✓ The level of satisfaction of the administration, representatives of the administration noted the benefits of the blockchain technology in checking the

[1] **Author development**

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authenticity of the data, collecting and analyzing statistical data. In 4 out of 5 institutions, as a result of the introduction of blockchain technology, it was found that the processes of information exchange were accelerated and errors were reduced.

✓ International experience, international comparison analyzes showed that the effectiveness and transparency of the educational process has been raised to a high level in countries that have widely implemented blockchain technology. In countries like Estonia and Singapore, diplomas and academic data are managed entirely by blockchain.

Table 2 Different areas of effectiveness of blockchain technology in the educational system[2]

Category	Сўров натижалари	Таъсири
Information security	High satisfaction	Blockchain plays a major role in ensuring data security.
Transparency	Good	Major reforms have been implemented in terms of data transparency and accountability.
Automation	Average	The automation system was perfected, the bureaucracy was reduced.
Authenticity of documents	High satisfaction	Blockchain is highly effective in verifying the authenticity of documents.
Information exchange	High satisfaction	Fast and accurate exchange of information was achieved through blockchain.

Table 2 above also includes important and different aspects in evaluating the effectiveness of blockchain technology in the educational system. Each category relates to a specific area in the education system, highlighting the impact and effectiveness of blockchain in these areas. The information in the table is analyzed in more detail as follows:

✓ Data security Blockchain plays a major role in ensuring data security. Data is stored in a decentralized manner, so it cannot be edited or changed. This, in turn, ensures the authenticity of educational information, including diplomas

[2] **Author development**

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and transcripts. Educational institutions and students are given the opportunity to ensure security through blockchain.

✓ Transparency, the role of blockchain technology in providing transparency is important. Since data is stored directly on the blockchain network, data exchange between educational institutions and other parties is open and transparent. It also helps to increase accountability, reduce bureaucracy and build trust in the learning process.

✓ Automation The effectiveness of blockchain in automation has been demonstrated. Automation systems provide an opportunity to reduce bureaucracy and create documents quickly and accurately. However, there is still a need for development and improvement in this area, as integration with other related technologies is required.

✓ Document authenticity The effectiveness of blockchain technology in verifying the authenticity of documents has been highly appreciated. The digital signature assigned to each transaction on the blockchain makes it easier to verify the authenticity of documents. This prevents the forgery of documents and makes it possible to officially recognize them.

Blockchain data exchange enables fast and accurate data exchange. Educational institutions that have implemented it have High efficiency in exchange changes has been achieved. This is especially important for official documents such as academic records, diplomas and certifications.

As can be seen from Table 2 above, the impact of blockchain technology in various fields in the education system is high, mainly in important factors such as security, transparency and authenticity of documents. But there is still a need for some development in the field of automation. The purpose of creating this table is to show the potential of blockchain to further digitize and reform the education system.

Summary

Extensive analyses have been conducted to assess the effectiveness of blockchain technologies in the higher education system and identify their potential. They have shown several key advantages of blockchain in education.

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The implementation of blockchain technology in the education system plays an important role in ensuring the security, transparency, and reliability of data.

It helps to increase trust among all participants in the education sector (students, teachers, administration) by protecting the authenticity of documents such as certificates, diplomas, and academic transcripts and protecting them from forgery. At the same time, blockchain has also been observed to achieve positive results in the field of automation and data exchange in the education system.

The rapid and accurate exchange of information through blockchain has the potential to improve the educational process and reduce bureaucracy. In addition, blockchain serves to make the educational process more transparent, that is, to ensure accountability in all matters. At the same time, the study also identified some challenges and limitations related to the implementation of blockchain technology in the national context. It noted the need to strengthen the institutional and technical infrastructure, as well as the legal framework, for the widespread adoption of this technology.

Also, it was found that there are many students and a lack of professionals with practical skills in the introduction of blockchain for experts and leaders of educational institutions.

It envisages conducting research aimed at further increasing the effectiveness of blockchain technology in the process of digitalization of higher education. It will also be important to further explore the role of blockchain in increasing the interest of students and teachers in education.

Based on the above conclusions, future research on the role of blockchain technology in the education system and its development will make a significant contribution to ensuring the effectiveness of reforms and innovative approaches in the field of knowledge.

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