

Social effects and risks of education digitalization in the context of a digital university

Bobro Natalia¹

Опубліковано	Секція	УДК
30.01.2025	Освіта/Педагогіка	339.9

DOI: <https://doi.org/10.5281/zenodo.14881856>

Abstract. The article considers the impact of digitalization on the transformation of the modern educational process in the context of the rapid development of technologies of the Fourth Industrial Revolution. The main focus is on the analysis of end-to-end technologies such as artificial intelligence, virtual and augmented reality, distributed ledger systems (blockchain), robotics and sensorics, as well as their impact on the educational environment. It is noted that digital innovations create new opportunities for modernizing the educational process, including personalization of learning, development of research competencies, expanding access to educational resources and the formation of lifelong learning. At the same time, digitalization creates certain risks, including the reduction of social interaction in the educational process due to the transition to a virtual environment, the spread of low-quality educational content outside state standards, and cybersecurity threats associated with the use of digital platforms. The problem of introducing digital technologies, in particular artificial intelligence and blockchain systems, is studied, and the importance of implementing technologies in a way that takes into account ethical and social aspects is emphasized. The prospects for the use of virtual reality technologies that improve students' cognitive activity, promote experiential learning and create interactive learning environments are analyzed. The role of robotics and sensorics in creating an adaptive learning environment that meets the modern needs of students in the digital economy is considered. The prospects of blockchain technologies for certificate management, competency assessment, and transparency in educational processes are also highlighted. The article concludes that in order to minimize the risks of digitalization, it is necessary to develop alternative transdisciplinary theoretical models of education that will ensure a balance between the integration of digital technologies and traditional pedagogical principles. Further research should focus on the social effects and risks of digitalization, taking into account the specifics of different educational contexts.

Keywords: digitalization of higher education, artificial intelligence, virtual reality, blockchain, robotics, digitalization.

Соціальні ефекти та ризики цифровізації освіти в умовах цифрового університету

¹ Ph.D, Doctor of Philosophy, Director of the digital department of the European University, director of the "NooLab & AI" scientific laboratory of the European University, ORCID: <https://orcid.org/0009-0003-5316-0809>

Анотація. У статті розглянуто вплив цифровізації на трансформацію освітнього процесу в умовах розвитку технологій четвертої промислової революції. Проаналізовано наскрізні технології, такі як штучний інтелект, віртуальна та доповнена реальність, блокчейн, робототехніка та сенсорика, і їхній вплив на освітнє середовище. Зазначено, що цифрові інновації сприяють модернізації освіти, персоналізації навчання, розвитку дослідницьких компетенцій, розширенню доступу до ресурсів та формуванню безперервного навчання. Водночас акцентовано на ризиках цифровізації, зокрема скороченні соціальної взаємодії через перехід до віртуального середовища, поширенні низькоякісного контенту поза державними стандартами та загрозах кібербезпеки. Досліджено роль штучного інтелекту, блокчейну та віртуальної реальності у створенні інтерактивних і адаптивних освітніх середовищ, які відповідають сучасним потребам студентів. Розглянуто перспективи використання робототехніки та сенсорики для підготовки до цифрової економіки. Зроблено висновок про необхідність розробки трансдисциплінарних моделей освіти, які забезпечать баланс між цифровими технологіями та традиційними педагогічними принципами. Подальші дослідження мають зосереджуватися на соціальних ефектах і ризиках цифровізації з урахуванням специфіки різних освітніх контекстів.

Ключові слова: цифровізація вищої освіти, штучний інтелект, віртуальна реальність, блокчейн, робототехніка, діджиталізація.

Introduction

The current stage of society's development is characterized by rapid changes driven by the impact of the Fourth Industrial Revolution. Education, as one of the key institutions of socialization and human capital development, faces major challenges, including the need to adapt to the speed of digital innovations. The mismatch between the pace of educational system digitalization and the dynamics of technological change poses the challenge for educators and scientists to create new approaches to transforming the educational process.

Despite the existing difficulties, the Fourth Industrial Revolution, based on the introduction of modern technologies, opens up wide horizons for the development of education. It encourages the educational sphere not only to integrate digital technologies into learning processes, but also to form a new learning format that involves individualizing the educational process, integrating digital solutions, creating a "seamless" learning environment, developing research and multidisciplinary competencies, as well as ensuring accessibility and continuity of education.

Along with the prospects of education digitalization, new social risks arise. Not only the successful transformation of the educational process, but also the paradigm shift in educational activities depends on the impact of end-to-end technologies. In this regard, it is important to determine which digital technologies are the most effective and functional for implementation in the education system, as well as what potential effects and risks they may cause.

The digital transformation of education is the subject of numerous studies. For example, N. Bobro in her work [1] analyzes the impact of digital transformation on learning processes, focusing on the peculiarities of the digital technology implementation in higher education institutions of Ukraine. The author emphasizes the need to create an adaptive information and digital space that meets modern challenges. The research by Luo T., Arcaute K. and Muljana P.S. [2] focuses on the integration of research-based learning into technical education, which demonstrates examples of the effective use of digital technologies to improve students' practical skills.

In addition, S. Yahodzinskyi [3] raises the important issue of ethical challenges associated with the implementation of anthropomorphic information networks and converging technologies in the educational environment. The author examines the potential risks and benefits of using such innovations to form intelligent learning support systems. At the same

time, M. Kaku [4] draws attention to the changes that await the labor sphere due to the spread of robots and artificial intelligence, which requires the adaptation of educational programs to prepare students for the new realities of the labor market. This emphasizes the need to adapt educational programs to prepare students for new labor market challenges. In this context, the issue of systemic digitalization of higher education, its impact on social processes and the risks associated with the use of digital technologies in the learning environment remains open.

Results

The rapid development of digital technologies creates new opportunities for modernizing the educational process, while at the same time posing challenges for society to adapt to such changes. One of the most promising areas of digital technology development in education is virtual reality. To better understand how digital technologies can change education, we will consider in more detail such an innovative technology as virtual reality. Virtual reality technology is usually understood as a set of hardware and software systems that aim to provide a comprehensive sensory illusion of presence in another environment [5, p.203].

A number of different articles [1; 3; 5; 6] are devoted to the analysis of the promising possibilities of virtual reality technology for education, revealing the main aspects of its application for educational purposes: for training or creating a basis for the didactic use of virtual reality in educational institutions, which helps to improve sensorimotor activity in the learning process, as well as for experimental training of students of chemical specialties.

There are researches devoted, on the one hand, to the design of educational VR applications, the use of helmets or desktop displays, and, on the other hand, to the study of the potential of this technology, the assessment of the quality and volume of information obtained with its help [3]. This indicates a growing interest in the development of educational environments that meet modern requirements and promote deeper student engagement in the learning process. Virtual and augmented reality technologies are expanding teaching and learning models that better meet the needs of 21st century learners. They are aimed at implementing integrated models of the educational process realization or developing learning environments in virtual reality.

Such prospects became possible thanks to research that examines the reasons for the active use of AR and VR and predicts their rapid implementation in the educational sphere. In addition, this technology allows teachers and students to access specialized materials regardless of time and space, improving the quality of problem solving and student motivation. Additionally, immersion in learning with the help of these technologies demonstrates a high level of student satisfaction and a positive attitude towards its use, which contributes to the efficiency of the educational process.

At the same time, robotics and sensorics are opening up new horizons for the integration of technologies into education [7;8]. They have become the means that allow to free a person from performing dangerous and monotonous activities, to carry out precision measurements, and to create conditions for the use of automated systems in the learning environment. This, in turn, contributes to a greater adaptation to the needs of modern students and the formation of skills necessary to work in the digital economy.

Social robots, which are one of the types of cyber-physical systems, are also being actively implemented in education [9, p.78]. They help people with attention deficit, act as mentors or groupmates, and act as educational agents with an emphasis on the development of social and psychological skills. This demonstrates that the technologies of the future are already becoming an integral part of the educational process, providing a more inclusive and personalized approach to learning.

It should be noted that artificial intelligence (AI) technology has a long history: its conceptual foundations were formulated before the advent of computer technology, but the practical transition from theoretical ideas to the development of real technological solutions

became possible much later. It was during this period that W. McCulloch and W. Pitts laid down the fundamental principles of artificial intelligence by presenting the world's first artificial neural network that models human thinking processes [10].

A significant amount of research has been devoted to the use of AI technology in education, in particular in the development of intelligent learning systems aimed at better performance of tasks and self-education of students, for analyzing various topics in the educational context using artificial intelligence and machine learning methods. It is considered that AI technology used in education creates a personalized learning experience, allows to achieve flexibility and individual customization that were previously impossible, as well as to develop an individual learning trajectory based on personal interests and career considerations [11;12].

In turn, distributed registry systems, in particular blockchain technology, open up new prospects for transforming educational processes due to their unique characteristics that ensure a high level of security, transparency, and decentralization of data.

Blockchain technology, which first appeared in 2008, has become one of the most innovative digital developments due to its unique characteristics, including decentralization, high security, reliability and data integrity. Having evolved from the concept of Blockchain 1.0 to more advanced Blockchain 3.0 models, this technology has found application in such areas as public administration, education, healthcare and science, but its implementation in education is still at an early stage [13, p.1230].

In particular, various blockchain applications have been created for educational purposes, which can be divided into twelve categories: certificate management, competencies and learning outcomes, assessment of students' professional abilities, protection of educational facilities, provision of a common learning environment, transfer of contributions and credits, obtaining consent for digital guardianship, competition management, copyright management, improving the level of students' knowledge, interaction in e-learning and support for lifelong learning [13;14]. However, unfortunately, very few educational institutions are using these opportunities. This is probably due to the fact that the problem of using this technology for educational purposes has not yet been sufficiently developed, but it can only be assumed that it is only a matter of time, given its scalability, privacy and cost.

In the context of the digital university, various scenarios for the application of blockchain technology exist, including:

1. Issuance and storage of certificates and diplomas. This is the most common area where blockchain technology is applied in education. Some universities use this technology to control the process of issuing and storing electronic certificates and diplomas. The use of blockchain technology in higher education began in 2014 when the University of Nicosia in Cyprus (UNIC) officially started using it for storing and verifying its diplomas. It also became the first university to accept tuition payments in Bitcoin [4]. Since then, UNIC has been publishing all thesis projects of its graduates (bachelor's, master's, and doctoral) on blockchain using its own development—the blockchain platform block.co. This platform is used not only by educational institutions but also in healthcare, public sector, transportation, and other fields.

In 2017, the Massachusetts Institute of Technology (MIT) developed the Blockcerts Wallet blockchain platform in partnership with Learning Machine. This is more than just a digital copy of a paper certificate. Since blockchain technology is decentralized and immutable, diplomas are securely protected. After being added to the application, students retain full control over their credentials forever.

2. Intellectual property protection. Today, blockchain is widely used in the field of intellectual property. Using this technology, one can record the fact and moment of creating an intellectual property object. The Binded platform is one of the projects providing such capabilities.

Currently, the structure of intellectual property objects is changing. Increasingly, these are digital records rather than physical objects. Blockchain technology has no alternatives when it comes to intellectual property rights for digital records. For example, data extracted from a distributed registry of digital objects can be the only source of evidence that a specific individual holds legal rights to these objects. This is particularly relevant for programming objects created daily.

3. Formation of an academic passport (portfolio). Blockchain is used to securely store information in an electronic portfolio, which can be formed throughout a person's life and contain complete, accurate, and immutable information about the portfolio owner.

The concept of blockchain-based portfolio formation involves two types of users: students and administrators. Students use a web application to upload their achievements into the database by filling out the appropriate fields and attaching the necessary documents. Administrators verify this data. If the data is confirmed, it is recorded in the blockchain. However, if the blockchain is private, the portfolio's formation capabilities depend on the resources of the educational institution where the student is enrolled.

Regarding public blockchains, they ensure human rights for authorizing academic certificates in a public registry in a reliable and sustainable format. At the same time, it is necessary to standardize the formats of electronic documents to ensure their automatic verification.

4. Accreditation of educational institutions. Accredited organizations can create "verifiers" on their websites, allowing users to upload their diplomas and check whether they were issued by accredited institutions, as well as publish issued diplomas in a public registry.

This allows any third party to verify:

- the diploma issued by the university to the student;
- whether the university is accredited in the public registry;
- whether the provided information is accurate.

5. Management of the educational process. The QualiChain project covers not only the accreditation of students and educational institutions but also has the potential for large-scale optimization of the educational process in universities, offering effective design of educational programs.

6. Identification solutions. In large universities, students and lecturers often need to identify themselves when interacting with different university departments. An alternative solution could be the Uport independent self-identification system, which uses the Ethereum blockchain.

An analysis of projects and studies related to blockchain technology in higher education indicates that this new technology is gaining popularity and entering the educational space. Its implementation is changing the concept of student-teacher interaction, making education more accessible and personalized.

End-to-end technologies, which have not been subject to detailed analysis, currently demonstrate relatively weak implementation in the educational sphere as self-sufficient tools. However, their interaction and integration can create a significant synergistic effect, in particular in cases of using integrator technologies, such as the "digital avatar" [15]. Digital technologies should be divided into the main ones that are being actively implemented (big data, virtual and augmented reality, robotics and sensorics, artificial intelligence, distributed ledger systems) [16; 17], and additional ones that have significant development potential (new production technologies, industrial Internet, wireless communication technologies and quantum technologies) [18].

The analysis of the use of end-to-end technologies in education allows to identify potential social effects and risks that may arise in the process of digital transformation of the educational system. For the purposes of this article, social effects are defined as the expected positive changes associated with the integration of digital technologies into the educational process,

while risks cover possible negative consequences that may accompany this process. The main expected social effects include:

Increasing the level of digital literacy and digital hygiene of all participants in the educational process.

Formation of complex structures that arise at the intersection of human resources and end-to-end technologies (artificial intelligence, big data, etc.), such as automated mentors (scaffolding technology), cobots, etc.

Changing the roles and positions of teachers, students, teaching and support staff, which involves the introduction of the ideas of “flipped classroom”, “flipped curriculum”, etc.

Expanding the target audience of students through the active implementation of remote access to educational resources of educational organizations, which makes education open and lifelong for various social groups.

Development of new forms (including blended ones) and methods of working with educational material aimed at individualizing learning, flexible scheduling and adaptation of students.

Formation of a new paradigm of the management process by an educational organization.

Increase in the amount of low-quality educational content, as the digital educational environment is overwhelmed with learning resources created outside the framework of state educational standards, which leads to a significant decrease in the level of students' training.

In addition to the positive changes brought about by the integration of end-to-end technologies in education, there is another side to digitalization, namely, possible risks:

Reduction of visual communication between participants in the educational process, transition to virtual space and digital educational environment, which in turn contributes to the loss of the social component in such an important area as education.

Increased security risks for individual students and teachers, as well as for the educational system as a whole. The placement of personal data on digital educational platforms or state internet resources does not guarantee their complete safety and the possibility of deletion after completion of specific tasks, and also creates risks of information leakage to third parties.

Transition to an exclusively electronic format of educational documents. Documents on professional retraining, advanced training, etc. are collected in a single national database, which reduces the level of their reliability. On the one hand, the digital format of a document is much more vulnerable to distortion, leakage, loss or compromise, and on the other hand, its storage period is shorter than that of paper carriers.

Ignoring the right of students and teachers to preserve traditional forms of education. The lack of alternatives in the process of digitalization forces participants in the educational process to learn new software that does not always correspond to their level of digital literacy or professional activity. In addition, this may require funding for their own advanced training or the purchase of sophisticated equipment.

Formation of a digital educational environment that makes decisions independently, ignoring the real participants in the educational process. The active introduction of artificial intelligence systems in education leads to the development of services that take over task solving instead of humans. This can make it difficult to control the educational process and generate unpredictable results.

In the future, in order to reduce the impact of the identified risks and threats, there is a need to create alternative transdisciplinary theoretical models of education. In addition, it is important to study the possible social effects and risks that may arise within the proposed models.

Conclusions

The analysis of the current state of digitalization in educational processes demonstrates the high potential of implementing advanced technologies such as artificial intelligence, virtual and augmented reality, blockchain, robotics, and sensor systems to enhance the efficiency of the educational environment. These technologies not only contribute to the personalization of the learning process, increased accessibility to education, and the development of innovative teaching approaches but also create conditions for forming a new type of interactive learning environment that considers the individual needs of each learner. They enable the integration of the educational process with modern technologies, thereby enhancing students' research and practical competencies. At the same time, it is essential to consider the need for adapting educational programs to changes in the labor market, the development of the digital economy, and the global transformations driven by the proliferation of new technologies.

In addition to the significant advantages of digitalization, there are several social risks, including the loss of the social component due to the reduction of visual communication, a decline in the quality of educational content due to its uncontrolled volume, and threats to personal data security. Furthermore, the transition to an exclusively digital environment may lead to a gap between technologically prepared and less technologically literate participants in the educational process, increasing the risks of inequality in access to quality education. Threats to personal data security, in turn, necessitate the creation of effective mechanisms for information protection, especially in the face of growing cyber threats. These challenges call for the development of strategies to improve digital literacy, foster a culture of safe use of digital technologies, and establish regulatory mechanisms for implementing digital solutions in compliance with national and international standards.

For the effective transformation of the educational system, it is crucial to develop alternative transdisciplinary education models that take into account the potential social effects and risks of digitalization. Such models should ensure a balance between traditional and innovative approaches to education, fostering the formation of a flexible and adaptive learning environment that meets the needs of modern students. Another important aspect is the integration of monitoring and evaluation mechanisms to assess the effectiveness of implementing digital technologies in educational processes, enabling timely responses to new challenges and the improvement of teaching methodologies. Additionally, creating conditions for lifelong learning and ensuring access to educational resources for all social groups is a key task that will contribute to the development of an inclusive educational environment.

Thus, the digitalization of education has significant potential for its modernization; however, the successful integration of advanced technologies requires a cautious approach that considers both the advantages and risks associated with their implementation. Only a balanced integration of digital innovations can ensure the quality, accessibility, and efficiency of the educational process, adapting it to the contemporary challenges and needs of society.

References

1. Бобро Н. С. Цифрова трансформація в освіті: вплив на навчальні процеси. Інвестиції: практика та досвід. 2024. № 2, С. 130–134. DOI: <https://doi.org/10.32702/2306-6814.2024.2.130>.
2. Luo T., Arcaute K., Muljana P.S. Integrating inquiry-based learning into engineering education: a case study. *Innovations in Education and Teaching International*. 2023. Vol. 60, no. 6. P. 836–847. DOI: <https://doi.org/10.1080/14703297.2022.2130393>.
3. Michio Kaku. 10 Robots, artificial intelligence, and the future of work. *Environmental Health and the US Federal System: Sustainably Managing Health Hazards*, 2019. P. 254
4. Філософія освіти: навчальний посібник. 2-ге видання / за наук. ред. академіка В. П. Андрущенко та ін.. Київ: Вид-во НПУ імені М. П. Драгоманова, 2021. 348 с.

5. N. Bobro, V. Bielikov, M. Matveyeva, A. Salamakha, V. Kharchun. Advancing Public Administration: Enforcing Strategic Methods and Utilising Tools. *Archs Sci.* 2024. Volume 74, Issue 3, Pages 201–206. DOI: <https://doi.org/10.62227/as/74332>.
6. C. Safarli, S. Kolach, M. Zhyvko, O. Volskyi, N. Bobro. Considering Globalisation Risks in the Formation and Implementation of International Investment Strategies. *Pak. J. Life Soc. Sci.* 2024. Volume 22, Issue 2, Pages 100284–100293. DOI: <https://doi.org/10.57239/PJLSS-2024-22.2.00776>.
7. Mahan K.R. The comprehending teacher: scaffolding in content and language integrated learning (CLIL). *The Language Learning Journal.* 2022. Vol. 50, no. 1. P. 74–88. DOI: <https://doi.org/10.1080/09571736.2019.1705879>.
8. Yahodzynskyi, S. Anthropomorphic information networks and converging technologies: challenge to humanity (vs), step forward?. *Artificial intelligence*, 2023. №1. С. 29-35. DOI: <https://doi.org/10.15407/jai2023.01.029>
9. Бобро Н. С. Особливості цифрової трансформації вищої освіти. *Інвестиції: практика та досвід.* (2024) № 3, С. 76–80. DOI: <https://doi.org/10.32702/2306-6814.2024.3.76>.
10. McCulloch, W. S., & Pitts, W. A logical calculus of the ideas immanent in nervous activity. *The bulletin of mathematical biophysics*, 1943. 5, p. 115-133.
11. Дущенко О. Сучасний стан цифрової трансформації освіти. *Фізико-математична освіта*, 2021. 28(2), 40–45. DOI: <https://doi.org/10.31110/2413-1571-2021-028-2-007>.
12. Джурило А.П., Глушко О.З., Локшина О.І., Маріуць І.О., Тименко М.М., Шпарик О.М. Трансформаційні процеси у шкільній освіті країн Європейського Союзу та США: монографія. ТОВ «КОНВІ ПРИНТ», 2018. Retrieved from <https://core.ac.uk/download/pdf/163088295.pdf>.
13. Хоменко О.О., Паустовська М.В., Онищук І.А. Вплив інтерактивних технологій на процес навчання і розвиток здобувачів вищої освіти. *Наукові інновації та передові технології*, 5(33), 1222–1231, 2024. DOI: [https://doi.org/10.52058/2786-5274-2024-5\(33\)-1222-1231](https://doi.org/10.52058/2786-5274-2024-5(33)-1222-1231).
14. Колодінська Я.О., Гудаков Д.О. Етапи проектування користувацького інтерфейсу. *Науковий вісник*, 1, 61–66, 2023. DOI: <https://doi.org/978-966-301-265-0/1.2023.61>.
15. Krap, S. Bataiev, N. Bobro, V. Kozub, N. Hlevatska. Examination of digital advancements: Their influence on contemporary corporate management methods and approaches. *Multidisciplinary Reviews*, 7, 2024. DOI: <https://doi.org/10.31893/multirev.2024spe026>.
16. Кучерак І. Цифровізація та її вплив на освітній простір в контексті формування ключових компетентностей. *Інноваційна педагогіка*, 2(22), 91–94, 2020. Retrieved from http://www.innovpedagogy.od.ua/archives/2020/22/part_2/22.pdf.
17. Марієнко М., Суких А. Організація навчального процесу у ЗЗСО засобами цифрових технологій під час воєнного стану. *Український педагогічний журнал*, 2, 31–37, 2022. DOI: <https://doi.org/10.32405/2411-1317-2022-2-31-37>.
18. T. Wambsganss, A. Janson, M. Söllner, K. Koedinger, J.M. Leimeister. Improving Students' Argumentation Skills Using Dynamic Machine-Learning-Based Modeling. *Information Systems Research*, 1–34, 2024. DOI: <https://doi.org/10.1287/isre.2021.0615>.