Digital transformation of higher education: towards a conceptual model of a digital university as a socio-technological institute

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Annotation. The article is devoted to the understanding of the digital transformation of higher education as a complex process that includes not only technological upgrades, but also institutional, cultural, and ethical rethinking of the university's functioning in the digital age. The main focus is on building a conceptual model of a digital university as a socio-technological institute that integrates IT infrastructure, educational activities, management services, ethical principles, and regulatory autonomy. Based on an interdisciplinary approach, three leading vectors of transformation have been identified: modernization of the educational process with an emphasis on individualization, implementation of flexible forms of education and digital avatars; automation of management decisions using algorithmic technologies, big data analytics, and artificial intelligence; and formation of a new IT architecture that ensures the creation of an integrated digital campus and electronic information and educational environment. A special emphasis is placed on the axiological dimension of digital transformation, which requires a rethinking of the traditional principles of higher education. In particular, the principles of accessibility, safety, efficiency, and quality of education in the context of digital interaction are analyzed. It is shown that the digital university should act not only as a technical and technological platform, but also as an open ethical and normative space focused on the development of academic integrity, protection of personal data, and the formation of digital autonomy and inclusion. The author substantiates the need to implement an ethical code for the digital university, create a system of ethical examination, and introduce digital pedagogy that combines innovative tools with humanitarian content. The article also examines the leading approaches to understanding the essence of the digital university: as a distance educational space, as a smart organization, as a digital ecosystem, and as a digital avatar of a classical university. It has been established that the most promising is a hybrid model that combines all these components, ensuring adaptability, technological integration, and value sustainability of the educational process. In this context, the digital university is seen as the institutional basis for the development of the knowledge economy, a research and education platform, a driver of social progress, and a strategic subject of digital modernization. Therefore, the digital transformation of higher education should be carried out not only along technical, but also social, humanitarian, and ethical vectors, which allows for its inclusiveness, legitimacy, and sustainable development.

Keywords: digital university, digital avatar, transformation of education, digitalization, ethics of education, digital culture.

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Цифрова трансформація вищої освіти: до концептуальної моделі цифрового університету як соціотехнологічного інституту

Анотація. У статті розглянуто цифрову трансформацію вищої освіти як системний процес, що охоплює технологічну модернізацію, інституційне оновлення та етичну переорієнтацію освітньої діяльності. Обґрунтовано концептуальну модель цифрового університету як соціотехнологічного інституту, що поєднує освітні, управлінські, цифрові й аксіологічні компоненти. Виокремлено три ключові напрями трансформації: зміну змісту і форм навчання (персоналізація, цифрові аватари, онлайн-сервіси), автоматизацію управління (AI, аналітика даних) та розвиток IT-інфраструктури (смарт-кампус, EIOC). Проаналізовано чотири моделі цифрового університету: дистанційну, смарт-організацію, цифрову екосистему та цифровий аватар. Підкреслено значення етичних принципів доступності, безпеки, якості й ефективності, що забезпечують легітимність трансформацій. Автором наголошено на необхідності формування етичної інфраструктури університету, впровадження цифрової педагогіки та системи етичної експертизи. Цифровий університет розглядається як ключовий суб'єкт цифрової модернізації, здатний формувати інноваційне, інклюзивне та етично орієнтоване освітнє середовище. Вказано, що цифрова трансформація вищої освіти має здійснюватися не лише за технічними, а й за соціальними, гуманітарними та етичними векторами, що дозволяє забезпечити її інклюзивність, легітимність і стійкий розвиток.

Ключові слова: цифровий університет, цифровий аватар, трансформація освіти, діджиталізація, етика освіти, цифрова культура.

Introduction

The Fourth Industrial Revolution, which is unfolding under the influence of artificial intelligence, the Internet of Things, big data, and cloud computing, is radically changing traditional social institutions. In the field of higher education, it raises the issue of institutional transformation of universities, necessitating a rethinking of their functions, structure, and interaction with society. Digital technologies are penetrating all components of the educational process - teaching, management, research, communication - forming the basis for a new type of university that functions as a socio-technological institute that integrates IT infrastructure, knowledge potential, and digital culture.

The formation of the digital university is associated not only with technical innovations but also with profound social changes, including globalization, massification of education, depersonalization of communications, the need for adaptive educational trajectories, and the transformation of the role of the teacher. According to modern research, digitalization is accompanied by the risks of lowering the quality of educational interaction, loss of academic autonomy, and increased inequality in access to knowledge, but at the same time, it opens up the potential for creating an individualized and human-centered educational environment. In this context, the digital university emerges as a response to the challenges of Industry 5.0, in which the humanitarian dimension of digital transformation is gaining key importance.

A new generation digital university requires conceptual modeling as a complex multi-level institution that integrates educational functions, digital services, analytical and management platforms into a single system. Particular attention is paid to the analysis of the ethical, organizational, and technological foundations of digital transformation, including issues of digital autonomy, institutional responsibility, personalization of the educational process, and new forms of academic integrity. Such a model should take into account the interface links between education, science, management, and digital platforms operating in the logic of the smart environment.

An analysis of current research allows us to draw a conclusion about the formation of a multicomponent view of the digital university as a socio-technological institute. Thus, the

works of S. Kubiv, N. Bobro, G. Lopushnyak et al. [1] and H. Lopuschnyak, O. Chala, O. Poplavska [2] emphasize the importance of analytical and legal, and socio-economic foundations for building a digital educational ecosystem. Particular attention should be paid to the research of G. Kortemeyer and colleagues [3; 6], which emphasizes that flexible learning formats, trust in algorithmic solutions, and the use of artificial intelligence in educational assessment are key indicators of the digital maturity of universities. The examples of the introduction of digital services in business (Ya. Kolodinska et al. [4]) and social inclusion strategies (A. Kozhyna [5]) show the influence of economic and management models on the formation of a new architecture of higher education.

The digitalization of the university environment is also associated with the restructuring of educational management and the implementation of new forms of motivation. A. Kozynec [7] emphasizes the role of the motivational environment in the growth of students' digital engagement. A. Krap, S. Bataiev, N. Bobro et al. [8] offer an institutional vision of digital transformation as a factor in changing management approaches that can be adapted to the university context. The works of O. Sklyarenko, S. Yahodzinskyi, O. Nikolaievskyi [9] and O. Khomenko and colleagues [10] prove that the introduction of digital interactive technologies in the educational process not only improves the involvement of students, but also creates conditions for personalized learning and soft skills development.

The concept of a digital avatar as an intermediary between the student and the digital environment is also gaining special significance. The research by N. Bobro, R. Hyshchuk, A. Strunhar, et al. [11] analyzes digital tools in the context of forming future strategies, and the work of S. Lysenko et al. [12] demonstrates the potential of AI in building a safe digital educational space. Thus, the analysis of the literature confirms that the digital university is not only a digital infrastructure but a holistic socio-technological institute that integrates the humanitarian, ethical, and technological dimensions of educational activities.

The purpose of the research is to provide a comprehensive justification for the digital transformation of higher education as a systemic process leading to the formation of a new type of digital university - a socio-technological institute that combines educational, managerial, and infrastructural innovation with humanistic and ethical and normative principles of functioning. The research is aimed at identifying key vectors of digital transformation (education, management, IT architecture), analyzing structural and functional models of the digital university, as well as defining the value, ethical, and regulatory frameworks that ensure the legitimacy and sustainability of transformations in higher education in a digital society.

Results

The digital transformation of higher education is emerging as a key stage in the evolution of the educational system, implemented at the level of public policy and aimed at the transition from an analog (traditional face-to-face) format to a digital educational environment. This transition is based on qualitative changes and modernization of the entire architecture of higher education institutions through the introduction of digital technologies.

If earlier innovative solutions were seen mainly as auxiliary tools for optimizing the educational process, today, digital technologies are the main means of ensuring its efficiency, flexibility, and quality. Their use in the educational process of the digital university contributes to the achievement of a whole range of goals, including:

- accessibility and continuity of education; mobility and learning outcomes;
- building individual educational trajectories;
- strengthening the role of research and project activities;
- flexibility of management mechanisms;
- development of interdepartmental network connections;
- increasing the competitiveness of an educational organization capable of training specialists with a high level of digital and flexible (soft) competencies [4;13].

The changing role of digital technologies in higher education is due to the fact that digitalization is now emerging as a social process, and education is a tool to support it. In this context, the activities of universities are increasingly subject to the logic of the digital economy, which requires new approaches to the organization of the educational environment.

An analysis of the key areas of digital transformation reveals three main vectors: transformation of the educational process, change of the management model, and updating of the IT infrastructure. In the field of education, the systemic elements - forms, methods, and content - are being updated through the introduction of digital solutions such as digital avatars of teachers and students, online courses, video conferencing, gamification, online training simulators, virtual, augmented, and mixed reality technologies, cloud services, digital laboratories, etc. [2;6;10].

In educational management, automation of processes using artificial intelligence, robotic systems, and algorithmic solutions plays a leading role. An electronic information and educational environment (EIEE) is being formed, which includes an electronic admissions office, a digital timetable system, an automated manager of educational programs, analytics of educational results, and an electronic dean's office operating on a “single window” principle.

In the field of university IT infrastructure, digital transformation is manifested in the creation of a communication environment - a “digital campus” - through the development of local networks, provision of classrooms with multimedia tools, introduction of digital libraries, electronic reading rooms, and platforms for remote interaction of participants in the educational process.

The resource potential of digital technologies is revealed through:

- unlimited access to educational content, implementation of the principles of lifelong learning;
- intensification of students' involvement in learning through interactivity and stimulation of critical thinking;
- development of media literacy and new norms of digital communication;
- transformation of written culture in the context of digital communication (correspondence, chats, social networks);
- increasing the importance of live interaction between teacher and student against the background of digital solutions;
- creation of personalized educational trajectories focused on individual needs;
- formation of leadership and team competencies necessary in the digital environment;
- development of digital security and literacy as basic skills for professionals in the digital age;
- improving the efficiency of management, planning, control, and resource provision for the educational process;
- ensuring open access to educational information for all participants in educational interaction [5;7;12].

Thus, the essence of digital transformation of higher education lies in the purposeful and comprehensive implementation of digital technologies with the aim of ensuring high quality of the educational process, forming a digital culture, developing digital and social and communication skills, as well as modernizing the university's management architecture according to the requirements of the digital society.

At the same time, digital transformation is not limited to technical innovations. It involves profound organizational and cultural changes: optimization of internal processes, algorithmization of management, flexibility of educational activities, and changes in the corporate culture of the university. These changes indicate the formation of the digital university as a new type of institutional model that integrates digital technologies into all areas of its activities and responds to the challenges of the digital age.

It should be emphasized that, as of today, a holistic concept of a digital university has not yet been fully formed. On the one hand, this is due to the lack of a single definition of the concept itself, and on the other hand, to an overly categorical approach to classifying a particular higher education institution as "digital" in the absence of clear boundary criteria. In this context, scientific literature offers several approaches to interpreting the phenomenon of the digital university, which can be grouped by functional, technological, and institutional characteristics.

The first approach considers the digital university as a virtual or distance educational institution that implements the educational process using distance learning technologies [3, p. 94]. This interpretation focuses on overcoming spatial and temporal barriers and providing unlimited access to digital educational content. The essence of this model lies in the use of electronic information technologies for the transfer and assimilation of knowledge in the format of electronic or online learning. At the same time, even traditional universities can, according to the current legislation in the field of education, implement distance learning technologies as part of their educational strategy. It is also important to develop forms of consortium cooperation between universities, which jointly create and implement online courses while maintaining their own institutional identity.

The second approach equates the digital university with a so-called smart university, which operates on the basis of the implementation of intelligent (smart) technologies [5, p. 30]. These are innovative technical and technological developments that create a new digital educational ecosystem for higher education institutions. A smart university is not only a technically equipped platform, but also an institutional environment focused on continuous education, flexible learning paths, and the widespread use of digital services. This model focuses on changing the paradigm of knowledge management and transitioning to personalized and adaptive learning that meets the requirements of the digital society. The smart university acts as an infrastructure unit within the broader concept of smart education, which ensures the implementation and development of intelligent digital solutions in education.

The third approach defines the digital university as a digital ecosystem that is formed during the industrial revolution and is characterized by the merging of physical and virtual environments [2, p. 7]. Such an ecosystem consists of interconnected digital platforms, services, and applications that ensure the integration of all participants in the educational process into a single information and communication space. This model pays particular attention to combining educational and research components, which contributes to the formation of university, academic, and scientific ecosystems integrated into global educational spaces. As part of the 4.0 model, an innovative university trains specialists for the digital economy, actively cooperates with business and the public sector, and integrates learning, research, management, and infrastructure into a single digital logic. In the future, such a university will emerge as a hub for multi-level communications, a platform for the implementation of interdisciplinary research and educational projects that respond to the challenges of the digital age.

The fourth approach interprets the digital university as a digital avatar — a digital replica or virtual model of an educational organization. The concept of a digital avatar, which originated in technical sciences and industrial modeling, is now actively used in the field of education [1, p. 262]. In this case, the university's digital avatar is a comprehensive digital representation not only of material and structural elements (campuses, document flow, internal departments), but also of social actors — students, teachers, administration — as well as processes taking place in the educational environment. This model enables in-depth analytics, modeling, simulation, and management of all stages of the educational process, as well as increased transparency and efficiency of university operations in a digital environment.

Summarizing these approaches, it can be argued that in the process of transformation, the digital university is becoming a dynamic social institution whose main task is to create a new educational space for training specialists capable of operating in the digital economy. In this sense, the digital university is a new institutional model that operates on the basis of digital

technologies in the educational process, management, and infrastructure, forming a digital educational environment that meets the needs of modern society.

It should be emphasized that digital transformation changes not only the tools for achieving university goals, but also the very logic of educational activities. It requires universities to be adaptable, flexible, and open to innovation, and also promotes the establishment of digital universities as avatars of classical universities — institutions that perform basic functions in the new digital reality: the transmission of knowledge, the transfer of sociocultural experience, scientific research, and the socialization of students. In this context, the potential of digital technologies becomes a critical factor in achieving high-quality results in the educational process and institutional development.

The digital university as a concept was formed in the context of the digital revolution and the development of Industry 4.0, which determined its interdisciplinary nature and the interconnection of technology, education, science, business, public administration, creativity, intellectual work, and innovative culture [11, p. 52]. In this sense, the digital university emerges not only as a new type of educational institution but also as an open socio-technological space that performs the strategic function of integrating knowledge, digital solutions, and management practices to form the future digital society.

The digital university can be seen as an entrepreneurial university of the new generation, which is becoming a leading center for educational, research, and innovative activities, and at the same time a driver of socio-economic development in regions in the knowledge economy. The target benchmark for the digital transformation of such a university is the development of modern information, telecommunication, and digital technologies to increase its competitiveness as a leading educational and scientific center. This involves ensuring the training and retraining of highly qualified specialists who possess not only professional knowledge but also a high level of digital literacy, making them sought after in national and international labor markets.

Thus, the digital university is an integral part of the institutional framework of the digital society. Its mission is not only to adapt to digital challenges, but also to ensure scientific and technological, and socio-economic development through the transformation of the basic mechanisms of educational activity. It is the innovative orientation, the ability to quickly integrate technological achievements, and the focus on the values of open education that enable the digital university to play the role of an active subject of digital modernization.

Digital technologies form the basis of the digital transformation of higher education. Their systematic implementation into the university structure ensures not only technical modernization but also the renewal of the entire architecture of the educational institution. These technologies play a key role in the transformation of the educational process, management model, and IT infrastructure, allowing educational activities to be reoriented toward innovation, mobility, and personalization [6;9;11]. Therefore, the formation of the digital university as a new type of institutional model is a logical consequence of the gradual digital transformation of higher education institutions, which meets the needs of modern society and the digital economy.

A review of the digital transformation of higher education has shown that its regulatory and value framework is defined by a set of principles that serve not only as functional guidelines for digitalization but also as an axiological basis for ethical analysis of transformational processes. The ethical specification of these principles allows assessing digital transformation not only as a technological innovation, but also as a socially significant process that affects the fundamental values of higher education in the context of the formation of the digital university.

The first principle is the principle of accessibility of higher education, which is defined as one of the main strategic goals of digital transformation. Its implementation means ensuring equal and open access to knowledge and information resources of the university for all participants in the educational process. In the context of the formation of the digital university,

this principle gains particular significance, as it is the basis for overcoming the digital divide, eliminating social marginalization, and removing territorial and technical barriers to access to quality education.

The second basic principle of the digital educational environment is the principle of security, which is inextricably linked to the principle of accessibility. Ensuring digital security is a necessary prerequisite for protecting the right to education and individual digital dignity. This principle involves creating technological and communication conditions at the digital university under which the personal data, digital autonomy, and privacy of participants in the educational process will be adequately protected. It also forms the basis of digital ethics, within which it is important to ensure the protection of personal information and human rights in the new communication environment.

The third principle — the principle of efficiency — takes on a dual meaning in the context of the digital transformation of higher education. On the one hand, it is a functional criterion for the compliance of digital education with the demands of the digital economy; on the other hand, it raises a number of ethical challenges in the interaction between universities and the business environment. In particular, in the classical humanistic paradigm, education is traditionally perceived as a selfless process of acquiring knowledge, while the digital environment sets new requirements for the pragmatic application of knowledge to achieve economic or individual goals. In this regard, the principle of efficiency requires ethical rethinking, which involves combining the value of knowledge as a public good with the need for economic expediency in the digital age.

The fourth principle – quality of education – is linked to fundamental principles of academic ethics, such as integrity, objectivity, impartiality, honesty, and the priority of public interest over private interest in the field of educational activity. In the digital environment, this principle takes on new emphasis due to the growing risks to academic integrity associated with digital assessment tools, copyright, openness, and transparency of information. Therefore, it needs a thorough ethical and academic rethinking to ensure its adequate interpretation and effective implementation in the new conditions.

A separate important task of digital transformation is to distinguish between the concepts of educational ethics and academic ethics. Academic ethics is a concretization of general educational ethics, adapting its basic norms to the specifics of the academic environment of the digital university. At the same time, academic ethics combines elements of scientific ethics (as a branch of applied ethics) and professional pedagogical ethics, thereby creating an ethical foundation for the holistic activities of the digital university.

For a comprehensive ethical and social analysis of digital transformation, the principle of accessibility requires regulatory and technological support for equal access to the digital educational space, avoidance of deepening existing educational inequalities, and prevention of the formation of new forms of social exclusion. The principle of security is relevant in the context of ensuring the technical resilience of educational infrastructure to digital threats and preserving personal freedoms in the digital environment, which should guarantee the rights and dignity of the individual.

In the context of the principle of efficiency, there is a need to adapt it to the digital economy, taking into account the social responsibility of the university and the humanistic nature of education. The principle of quality of education in the digital environment requires not only formal control, but also strengthening the role of academic integrity, transparency, and public trust.

Thus, the ethical and normative transformation of the digital university involves the formation of an ethical regulation system consisting of the following components:

- a code of ethics for the digital university;
- an ethical review system represented by ethics consultants and specialized committees;

– the implementation of a comprehensive ethical education system (training courses, methodological recommendations, monitoring of ethical challenges and problems).

An analysis of the existing regulatory framework has shown that the success of the digital transformation of higher education largely depends on the consistency and quality of ethical support. To this end, it is necessary to conduct an in-depth humanitarian assessment of the potential risks of unequal access, digital communication conflicts, and social polarization; to reflect on the role and values of contemporary educational ethics in the context of digital culture; to integrate the basic principles of digital ethics and philosophical ethics into university activities; to rethink academic ethics as a key component of digital pedagogy; and to interpret the principle of educational efficiency, taking into account the challenges and opportunities of the digital economy.

Therefore, the formation of the digital university requires a comprehensive ethical and regulatory transformation of educational activities, which is an important condition for the legitimacy, inclusiveness, and sustainable development of higher education in the digital age.

Conclusions

The digital transformation of higher education is not limited to the technical modernization of educational processes, but is a multidimensional socio-technological phenomenon that encompasses the structural restructuring of the university model, a change in the logic of knowledge management, a rethinking of the roles of teachers and students, and the formation of a new type of educational space. The research substantiates that the digital university is an institutional model that combines the functions of digital infrastructure, educational services, analytical platforms, ethical self-regulation, and value autonomy. Its formation is taking place in the context of the challenges of Industry 5.0 and the global digital economy, which necessitates an interdisciplinary approach to managing transformational processes in education.

The analysis revealed three key vectors of digital transformation: transformation of the learning process through personalization, virtualization, and gamification of educational content; transformation of the university's management model through automation, big data analytics, and artificial intelligence; modernization of IT infrastructure, which ensures the integration of all participants in the educational process into a single smart environment. Particular attention is paid to the concept of a digital avatar as a tool for modeling the institutional logic of a university in a digital environment, which allows for real-time monitoring, simulation, and optimization of educational interaction.

A summary of the ethical and regulatory aspects of digitalization has made it possible to determine that qualitative transformation is only possible if institutional ethics are established at digital universities. The principles of accessibility, security, efficiency, and academic integrity should become the axiological basis for managing digital change. An important component of the new university model is the introduction of ethical review systems, digital interaction regulations, and the integration of humanitarian expertise into the process of digital modernization. Thus, the digital university is not just an instrumental structure, but a new type of social institution that shapes the future of higher education based on innovation, inclusion, and ethical responsibility.

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