ПЕДАГОГІЧНА АКАДЕМІЯ:
НАУКОВІ ЗАПИСКИ

ІНФОРМАЦІЙНО-КОМУНІКАЦІЙНІ ТЕХНОЛОГІЇ В ОСВІТІ

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An Integrative Model for a Digital University in Modern Education

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Abstract*. The integrative model of a digital university is pivotal in transforming modern education, offering an innovative framework for organizing educational processes. In the context of global digitalization, developing an integrated digital university model enhances learning efficiency, promotes personalized educational pathways, and strengthens the competitiveness of higher education institutions. This study addresses the critical need to integrate digital platforms, automate educational processes, and cultivate an adaptive learning environment.* ***Purpose****: This article aims to develop an integrative model of a digital university that synthesizes pedagogical, technical, and managerial elements to adapt the educational process to the demands of digital transformation. The research* ***methodology*** *includes analyzing contemporary scientific sources, comparing theoretical and practical approaches to educational digitalization, and modeling an integrative digital university system.* ***Results****: The findings indicate that a digital university operates as a complex system with four key*

components: digital learning format, digital environment, digital resources, and digital platform. The digital learning format incorporates innovative technologies such as virtual reality, interactive simulators, and digital simulations, fostering deeper student engagement with learning materials and promoting autonomy. The digital environment integrates physical and virtual infrastructures, including intelligent control systems, cloud technologies, and high-speed Internet, forming the foundation for university operations. Digital resources provide access to educational materials, electronic libraries, massive online courses, and databases, streamlining educational processes. The digital platform serves as a multifunctional tool that unifies educational, management, and analytical functions, enhancing administrative efficiency and flexibility in learning. However, implementing digital technologies encounters several challenges, such as limited funding, the need to improve digital literacy among teachers and students, and the necessity to uphold ethical standards. ***Conclusions****: The study underscores the importance of a comprehensive approach to educational digitalization, emphasizing the integration of advanced technologies into the learning process. Future research could explore practical implementation of the digital university model, assess its effectiveness across diverse socio-cultural contexts, and develop strategies to support the sustainable advancement of digital education.*
Keywords*: digital university, digitalization, integrative model, digitalization, artificial intelligence.*

Інтегративна модель цифрового університету в сучасній освіті

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Анотація. *інтегративна модель цифрового університету відіграє важливу роль у трансформації сучасної освіти, забезпечуючи інноваційний підхід до організації освітнього процесу. У контексті глобальної цифровізації суспільства розробка комплексної моделі цифрового університету дозволяє підвищити ефективність навчання, сприяти персоналізації освітніх траєкторій та забезпечувати конкурентоспроможність закладів вищої освіти. Актуальність дослідження зумовлена необхідністю інтеграції цифрових платформ, автоматизації освітніх процесів і розвитку адаптивного навчального середовища.* ***Метою*** *статті є розробка інтегративної моделі цифрового університету, яка поєднує педагогічні, технічні та управлінські аспекти для адаптації сучасного освітнього процесу до викликів цифрової трансформації. У процесі дослідження використано* ***методи*** *аналізу сучасних наукових джерел, порівняння теоретичних та практичних підходів до цифровізації освіти, моделювання інтегративної системи цифрового університету. Основні* ***результати*** *показують, що цифровий університет є складною системою, яка складається з чотирьох ключових векторів: цифрового формату навчання, цифрового середовища, цифрових ресурсів і цифрової платформи. Цифровий формат навчання включає інноваційні технології, зокрема віртуальну реальність, інтерактивні тренажери та цифрові симуляції, які сприяють глибшій взаємодії студентів з навчальним матеріалом та розвитку їхньої автономії. Цифрове середовище поєднує фізичну та віртуальну інфраструктури, включаючи інтелектуальні системи управління, хмарні технології та високошвидкісний інтернет, створюючи основу для функціонування університету. Цифрові ресурси забезпечують доступ до освітніх матеріалів, електронних бібліотек, масових онлайн-курсів і баз даних, сприяючи інтеграції освітніх процесів. Цифрова платформа виступає як багатофункціональний інструмент для об'єднання освітніх, управлінських та*

аналітичних функцій, полегшуючи адміністративні процеси та забезпечуючи гнучкість у навчанні. Водночас впровадження цифрових технологій стикається з низкою викликів, серед яких – недостатнє фінансування, потреба у підвищенні цифрової грамотності викладачів і студентів, а також необхідність дотримання етичних стандартів. ***Висновки*** *дослідження підкреслюють важливість комплексного підходу до цифровізації освіти та інтеграції новітніх технологій у навчальний процес. Подальші дослідження можуть бути зосереджені на практичних аспектах впровадження моделі цифрового університету, оцінюванні її ефективності у різних соціокультурних контекстах та розробленні стратегій забезпечення сталого розвитку цифрової освіти.*

Ключові слова: *цифровий університет, діджиталізація, інтегративна модель, цифровізація, штучний інтелект.*

A general statement of the problem and its connection with important scientific or practical tasks. In the modern world, digitalization has become a key driver of transformations across all spheres of societal life, including education. Traditional models of organizing the educational process no longer meet contemporary challenges, particularly the demands for flexibility, personalized learning, and the integration of innovative technologies. Universities, as leading higher education institutions, face the necessity of implementing digital solutions that ensure the efficiency, accessibility, and competitiveness of educational programs.

Despite significant progress in the use of digital platforms and tools, many educational institutions lack a comprehensive approach to integrating digital technologies, which complicates efforts to achieve sustainable development and alignment with international standards. Specifically, challenges include insufficient technical infrastructure, low levels of digital literacy among educators and students, and the need to adapt curricula to innovative formats.

The issue of developing an integrative model of a digital university that combines pedagogical, technical, and managerial aspects remains insufficiently explored in scientific literature. The importance of this research lies in the potential to create a systematic approach to the digitalization of the educational process, which would optimize the organization of learning, enhance its adaptability and interactivity, and contribute to improving the quality of education on a global scale.

Thus, the relevance of the study is determined by the necessity to adapt higher education institutions to the conditions of digital transformation and to create the prerequisites for the effective functioning of a digital university in the context of the dynamic changes of the global educational environment.

Analysis of recent research and publications. An analysis of current research on digital transformation in education and other sectors highlights key areas of development and identifies existing gaps. The works of Y.O. Kolodinska, O.V. Skliarenko, and O.Y. Nikolaievskyi [1] explore the practical application of digital services in business, providing a foundation for further research on their impact on educational processes. Additionally, the research of P.V. Huk and O.V. Skliarenko examines the economic feasibility of modernizing enterprises [2], a concept that can also be applied to educational institutions.

A group of Ukrainian scientists has made significant contributions to the study of interactive technologies in education, as seen in their work “Digital Interactive Learning Technologies as an Integral Part of the Modern Educational Process” [3], which aligns with the concept of a digital university. A similar topic was explored by O. Khomenko et al. [4], who emphasize the impact of interactive technologies on student development. Additionally, S.M. Yahodzinsky [5] focuses on the socio-cultural aspect of digitalization, providing a foundation for integrating digital tools into interdisciplinary research.

O. Dushchenko [6] analyzes the state of digital transformation in education, identifying limitations in the implementation of digital technologies in educational institutions. Similarly, S. Karpliuk [7] examines the specifics of digitalizing the educational process in higher education, emphasizing the need for transformation in the learning environment.

A. Kozhina's work [8] presents approaches to inclusive economic development through digitalization, providing an important context for analyzing the educational system. Foreign researchers from Edinburgh, B. Williamson et al. [9], examined the impact of the COVID-19 pandemic on distance learning, highlighting the crucial role of digital technologies during crises. N. Verina and O. Titko [10] proposed a conceptual framework for digital transformation, offering a methodological foundation for adapting educational systems to contemporary challenges.

Despite the breadth of existing research, the integration of digital environments, platforms, and tools into a comprehensive model of a digital university remains insufficiently addressed. Issues such as process automation, the personalization of learning, and the adaptation of innovative approaches to traditional systems are still unresolved. This study aims to bridge these gaps by proposing a systematic approach to developing a digital university as an integrative model, with a focus on contemporary technological, pedagogical, and managerial aspects.

Identification of previously unresolved parts of the general problem. A review of the relevant literature reveals that the concept of a digital university holds significant potential in modern education. However, aspects such as integrating digital platforms to automate the educational process, personalize learning paths, and create adaptive learning environments remain underexplored. Current scientific sources lack a holistic approach that combines the technical, pedagogical, and managerial components of a digital university.

Our research aims to thoroughly address these aspects by proposing an integrative model of a digital university that responds to the current challenges of digital transformation.

Formulation of the objectives of the article. The purpose of the study is to develop an integrative model of a digital university that combines pedagogical, technical, and managerial aspects to adapt the modern educational process to the demands of digital transformation.

The objectives of the study are:

1) To examine the current state of digital transformation in higher education and its impact on the educational process.
2) To analyze the use of digital platforms, tools, and resources in creating a digital university environment.
3) To identify the key benefits of integrating innovative digital technologies into the educational process.
4) To develop a conceptual framework for a digital university, focusing on its four main components: learning format, digital environment, digital resources, and digital platform.
5) To substantiate pedagogical approaches for integrating digital technologies into the educational process, aiming to enhance student autonomy and adapt the educational environment to contemporary challenges.

These objectives outline a comprehensive research approach designed to address existing gaps in the scientific literature and enhance digital education models.

Presentation of the main research material with full justification of the scientific results obtained. Digital transformation in contemporary conditions is a crucial global process that spans all areas of social development. The growth of the digital economy is accompanied by a more competitive environment, enhanced digital

literacy, improved professional qualifications of specialists, and the modernization of business structures and public services. At the heart of these changes is the introduction of Internet infrastructure and the integration of digital technological solutions, which enable effective adaptation to modern challenges.

In this context, the concept of a digital university as a model for modern educational institutions is particularly significant. A digital university is an integrative system that utilizes advanced digital technologies, software, and innovative approaches to organizing the educational process, while also engaging highly qualified specialists. As a result, universities can maintain high competitiveness in global rankings by meeting key criteria, including education quality, graduate employability, and the level of research and development.

Achieving these indicators is largely facilitated by the use of modern digital platforms, which enable the automation of educational processes, data integration, and the personalization of learning paths. Universities adapting to the digital age are characterized by high levels of technical and informational support, teachers' readiness to use digital tools, and effective management of the educational environment.

Digital technologies are becoming increasingly vital in the educational process, driven by the proliferation of smart digital tools, cloud computing, public high-speed internet, artificial intelligence, virtual reality, and robotics. These innovations not only modernize educational infrastructure but also enhance its adaptability to the dynamic changes of the modern world.

In this study, the digital university is conceptualized as an integrative methodological construct, consisting of four interdependent vectors: learning format, digital environment, digital resources, and digital platform. This approach enables the digital university to be viewed not only as a space for the implementation of cutting-edge technologies but also as a comprehensive model that integrates pedagogical, technical, and managerial aspects.

Let us take a closer look at each of the vectors. Thus, the digital learning format is not limited to the use of digital technologies for organizing distance learning, but includes a wide range of innovative tools, such as digital simulators, virtual reality helmets and glasses [11, p.252], game simulations and other technologies. This format is aimed at using digital technologies, taking into account their unique properties and potential for creating a specific educational environment that differs from the traditional one.

Digital technologies are fundamentally transforming the educational process by enabling remote access to resources and enhancing student autonomy and responsibility. At the same time, they encourage the shift away from outdated approaches, such as the diminishing emphasis on the encyclopedic format of knowledge, while strengthening the practical component through simulations of the professional environment.

Empirical studies show that while the use of virtual reality in education may lead to an increased cognitive load on students [12, p.3], it also contributes to improved learning outcomes. This highlights the need for a thorough revision of the pedagogical paradigm, one that not only integrates digital technologies into the educational process but also incorporates them into a broader system of educational approaches and strategies. Such an approach will enable more effective adaptation of digital tools to the needs of modern education, ensuring optimal learning conditions.

The digital format of education is not just an external structure but also a conceptual framework that reshapes the notion of higher education to meet the demands of Industry 4.0 [13, p.22]. The digital university serves as an initial stage in the development of the 4.0 university model, or the bio-digital university, which synthesizes digital and biological domains [14, p.64]. At the same time, it fosters the development of digital competencies by integrating digital technologies into the educational process. The content of education must be forward-thinking, focusing on

areas that are under-researched or just beginning to emerge, rather than relying solely on traditional approaches. While existing knowledge remains important, this calls for expanding and rethinking it in the context of new trends.

The educational process should focus on addressing the long-term challenges of our time, such as humanity's adaptation to new technological conditions, defining the role of individuals in the digital era, and understanding the impact of digital transformations on social processes. The digital learning format must also be grounded in clearly defined values related to digital technologies, the formation of which is still in its early stages. The academic community must establish ethical and practical principles for using digital tools to ensure the sustainable development of both education and society as a whole.

It is important to note that the digital university as a phenomenon only emerges when the next vector is established—namely, the appropriate environment, which is a fundamental prerequisite for its existence. Therefore, the digital environment is a key element of the digital university concept. First and foremost, the digital environment encompasses the technical infrastructure of the university: access to a fiber optic network, stable high-speed internet, wireless network availability, automated control systems based on the Internet of Things (intelligent infrastructure), integrated with artificial intelligence, and more. Additionally, it includes the university's cloud space, digital platform, and digital resources that support the functioning of all elements of the educational ecosystem. The technical component serves as the framework or foundation of the digital environment, while the cloud space acts as its content.

The digital environment represents the integration of physical and virtual spaces into a unified digital infrastructure. For instance, the use of virtual reality technologies requires the creation of an immersive physical environment that enables users to experience virtual reality. This is supported by various studies [15, p.70], which emphasize that merely using a virtual reality headset is not enough; the physical

conditions must closely mimic the real-world environment outside the classroom. Therefore, providing a wireless network connection alone is insufficient for establishing a fully functional digital environment. Higher education administrators must recognize that ensuring access to digital networks goes beyond creating a comfortable setting for students. It is a crucial prerequisite for the effective operation of the intellectual educational infrastructure, which in turn determines the institution's capacity to meet the evolving demands of digital transformation.

The intellectual infrastructure of the university is a smart system built on Internet of Things technologies, big data, and digital analytics. It mirrors the concept of smart cities and reflects the institution's digital maturity. Through an integrated system and a network of microsensors connected via wireless connections to analytical databases, this system enables real-time data collection and rapid responses to critical situations. Additionally, it addresses everyday tasks such as monitoring the visits of students and university staff to buildings, regulating temperature settings, and managing parking space availability, among other functions.

Therefore, the concept of a digital university cannot be discussed without considering its digital environment as a fundamental component.

The third element, digital resources, plays a crucial role in implementing the concept of digital transformation in education. These resources include digital platforms, social networks, electronic libraries, web resources, massive open online courses, interactive simulators, virtual exhibition stands, databases, and other tools designed for educational purposes. As an integral part of the digital university, these resources facilitate the effective integration of the digital environment into the educational process. Despite the significant potential of digital technologies, their successful implementation requires substantial resources, including funding, time, technical support, specialized training, and a deep understanding of the specific characteristics of these technologies.

The final element, the digital platform, is a multifaceted concept that serves multiple functions. It acts as an algorithm for managing relationships among participants, a platform for hosting content or facilitating transactions, a collection of digital tools integrated into an information and analytical system, and an environment with supporting software. Digital platforms leverage the principle of referral marketing, which involves informal communication among people whose messages are shared in a chain. The accumulation of likes, reviews, reposts, and comments enables the ranking of various entities, such as hotels, companies, drivers, manufacturers, and celebrities in the entertainment industry [3;14].

The field of higher education has been significantly influenced by business trends due to several key factors. Firstly, employers now demand specialists with competencies tailored to the digital economy, such as programmers, marketers, and other professionals. Secondly, the rapid development of digital platforms in non-academic industries has created a competitive risk for universities, particularly with the rise of alternative entities that can offer high-quality educational products. Thirdly, the growing expectations of students and their parents, shaped by the convenience of digital solutions in other sectors, have increased the pressure on universities to meet these standards in providing information and other services.

Many universities today face the challenge of maintaining competitive attractiveness, a problem not only stemming from deficiencies in visual presentation and marketing strategies, but also from the inefficient use of key resources such as time, finances, and human capital. Cumbersome bureaucratic processes and the lack of flexible digital tools hinder their ability to quickly adapt to new challenges and deliver a high-quality educational experience.

A web platform that integrates the university’s analytical database, educational resources, library holdings, and external information sources — including those not belonging to the university — forms the foundation for implementing the concept of a

digital university within the current organizational structure. This platform operates on the “single window” principle, providing students with access to all necessary data related to their educational profile, along with a wide range of university services. This integration helps eliminate administrative barriers and reduces the inefficient use of personal time.

Therefore, the development of the university’s digital platform relies not only on technical solutions but also on a conceptual vision that positions the platform as a social tool tailored to the needs of students. This approach enables the creation of a flexible, interactive, and adaptive environment that enhances communication effectiveness, optimizes resource access, and supports the development of a student-centered model of higher education management.

Conclusions. In the course of this research, the goal was successfully achieved: an integrative concept of a digital university was developed, incorporating pedagogical, technical, and managerial aspects. The digital university, as conceptualized in this study, is an integrative methodological construct consisting of four interdependent vectors: educational format, digital environment, digital resources, and digital platform. This approach allows the digital university to be viewed not only as a space for the integration of cutting-edge technologies but also as a comprehensive model that aligns with the demands of contemporary society.

The training format is defined as a key vector, encompassing tools such as virtual reality, interactive simulations, and digital simulators, all of which contribute to the personalization of the educational process and the development of student autonomy. This approach enables the effective integration of innovative technologies into the educational environment

The digital environment, which integrates physical and virtual infrastructure, is considered a fundamental element of the digital university concept. At its core are intelligent infrastructure, cloud technologies, and automated management systems that

optimize resources, enhance the efficiency of educational processes, and ensure flexibility in university management.

Digital resources, such as electronic libraries, databases, massive open online courses, and interactive tools, are integral to a digital university. Their implementation enables access to educational materials, automation of processes, and integration of diverse data.

The digital platform is viewed as a multifunctional tool that combines educational, management, and analytical functions, fosters personalization of learning, and helps eliminate administrative barriers.

Thus, the developed concept of a digital university offers a systematic approach to integrating cutting-edge digital technologies into the educational process, addressing the modern challenges of digital transformation. Future research should focus on the practical aspects of implementing this model, evaluating its effectiveness across various sociocultural contexts, and developing ethical principles for the use of digital technologies in education.

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