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Technologies and Innovations in The Educational Process: Experience of the University of the Future

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Abstract: The concept of university refers to a forward-thinking, innovative educational institution that implements the latest advancements in technology and pedagogy. The purpose of the research is to explain technologies and innovations used at the future-oriented university and to outline their impact. The research objectives are the following: to describe the concept of university of future; to explain what technologies and innovations are integrated into the educational process; and to describe the peculiarities of their using. Studying involved mixed methodology, particularly surveys and questionnaires; in-depth interviews; observational studies; content analysis; and ethnographic and pedagogical method. Descriptive statistics, multivariate analysis, thematic analysis and narrative analysis were used for data analysis. The study was carried out among faculty members and university administrators in February-April, 2024. The findings showed that the participants of the educational process understand the university of future as an institution focusing on the formation of professional competences among students through the use of innovative techniques. Also, it is referred as an innovation center, research and development institution, digital university or student-centered university. The university of future is characterized by technology-enhanced learning, research and innovation, practical learning, interdisciplinary approach, personalized learning, student-centered pedagogy, and life-long learning opportunities. The university of future applies a number of technological advancements that enhance the efficiency of the educational process. They include artificial intelligence, virtual reality, Learning Management Systems, and cloud computing. The pedagogical innovations are related to blended learning, flipped classroom, personalized learning, project-based learning, game-based activities, and collaborative learning. The implementation of technological advancements and pedagogical innovations requires using organizational and pedagogical measures.

Keywords: artificial intelligence, blended learning, competences, gamification, project-based learning, student-centered approach, teaching practices.

Introduction

The intensive development of the information society, the significant political and socio-economic changes, the impact of the pandemic and Russian-Ukrainian war which caused displacement, migration and educational disruptions, require transformations in many fields, particularly in the education system. Currently, digitalization and informatization have brought a number of digital technologies and pedagogical innovations to transform the educational environment (Díaz-García et al., 2022). This includes the use of online learning platforms, personalized education through data analytics and artificial intelligence (AI), as well as educational activities based on virtual and augmented reality. Digital tools impact not only the learning and teaching practices; they enable global collaboration, support lifelong learning and modular programs, and provide access to open educational resources, making education more flexible and tailored to individual needs. As the society becomes increasingly digital, institutions of higher education must adapt to these changes, ensuring they remain relevant and effective when preparing students for a rapidly evolving world.

The university of the future refers to a forward-thinking, innovative educational institution that implements the latest advancements in technology and pedagogy to provide an enhanced learning experience. It emphasizes the integration of digital tools and platforms, enabling online and hybrid educational environments that consider diverse students' needs and learning styles (Gadhoum, 2022). The concept has evolved over time, but it gained significant meaning in the late XX and early XXI centuries. It is influenced by rapid technological advancements, changes in workforce demands, and changes in educational paradigms (Mohiuddin et al., 2023).

For example, the rise of the internet and digital technologies in the 2000s transformed how education could be delivered and introduced online learning and digital classrooms. In the 2010s, with the advent of Industry 4.0, it became necessary to focus the educational process towards the formation of certain skills like critical thinking, problem-solving, and adaptability (Díaz-García et al., 2022; Rosak-Szyrocka et al., 2022). The United Nations Sustainable Development Summit held in 2015 adopted the Sustainable Development Goals. As the result, growing awareness of environmental and social issues has led to universities integrating sustainability and social responsibility into their curricula.

It is worth mentioning that the university of the future is an object of a number of official reports, papers, and visionary documents published by international organizations, think tanks, or leading educational institutions. One of the important documents is “Trends Shaping Education” adopted by The Organisation for Economic Co-operation and Development (OECD). The report identifies the significant global trends in education such as globalization, demographic changes, technological advancements, environmental sustainability, and social dynamics, and discusses how these trends might shape the goals, content, and delivery of education (McCarthy et al., 2023).

Also, the document describes future scenarios that illustrate how education might evolve in response to these trends. The concept of university of future has long been a topic of discussion in the United Nations Educational, Scientific and Cultural Organization (UNESCO) resulted in the prominent publication “Rethinking Education: Towards a Global Common Good?” (Philip & de Wit, 2022) Additionally, World Economic Forum produced several reports on the future of education, particularly “New Vision for Education” reports that outline the skills needed for the future workforce and the implications for higher education institutions.

In this context, it can be argued that the university of future requires the implementation of pedagogical innovations and technological advancements to adapt to evolving educational needs (Díaz-García et al., 2022; Gadhoun, 2022). Currently, the efficient educational environment uses AI for personalized education, virtual and augmented reality for immersive learning, and global collaboration through digital communication tools (Mohiuddin et al., 2022). The university of the future is also characterized by its commitment to lifelong learning, offering modular courses support continuous skill development (Rosak-Szyrocka et al., 2022). Importantly, such university is inherently inclusive and it aims to provide equal access to high-quality education for all students, regardless of their geographical location, socioeconomic background, or physical abilities (McCarthy et al., 2023). The use of online learning platforms and open educational resources makes education more affordable for all the participants of the educational process (Salama & Hinton, 2023).

Research Problem

The existing conditions necessitate the profound transformations within the higher education system. Currently, the institutions of higher education are facing a multitude of changes driven by technological, social, economic, and environmental factors. A number of recent scientific works explain the development of the university of future due to the rise of digital technologies, AI, and big data analytics revolutionizing the educational process significantly (McCarthy et al., 2023). Potapchuk, Lutsyk, Hevko, and Buyak (2020) indicate that online learning platforms, virtual classrooms, and AI-driven personalized learning are becoming increasingly common nowadays. At the same time, there is a growing emphasis on lifelong learning and continuous skill development to build professional competencies among students (Rosak-Szyrocka et al., 2022).

The special attention is paid towards pedagogical innovations and improvements within the educational environment. For instance, Chilton, Hanks, and Watson (2024) state that blended and hybrid learning models offer greater flexibility and accessibility as well as adjust the educational

practices to diverse students' needs. Personalized learning was found to be one of the important components of efficient educational process (Shemshack & Spector, 2020). Some scholars insist that using AI and data analytics help create personalized learning scheme and design individual learning trajectories tailoring education to individual student's strengths, weaknesses, and career goals (George & Wooden, 2023).

The concept of university of future is closely related to introduction of interdisciplinary programs at the educational institution (Tymkiv, 2021). Increased focus on interdisciplinary studies to address complex global challenges, encouraging students to draw knowledge from multiple fields and apply it in innovative ways. Additionally, moving from traditional learning to competency-based education, where students progress based on their mastery of specific skills and knowledge (Ridei, 2021). Zhang and Chen (2023) add that to enhance the effectiveness of future specialists' training, it is required to strengthen the partnerships with industry. This ensures that curricula comply with current and future job market needs, providing students with relevant skills and real-world experience.

Some findings equate the university of the future and the smart university (Potapchuk et al., 2020). But certain scholars suggest that there are some differences between these notions (Gadhoun, 2022). Since the first one is characterized by holistic transformations, including pedagogy, administration, infrastructure, and engagement with society, the second one focuses upon the integration of advanced technologies such as Internet of Things (IoT), AI, big data, and smart infrastructure to enhance the educational process. According to Potapchuk, Lutsyk, Hevko, and Buyak (2020), both concepts are future-oriented and prioritize innovative approaches to education. The university of the future and the smart university are similar phenomena because of implementation of technological advancements and orientation towards enhancement of students' experience through personalized and flexible learning.

In the Ukrainian context, the concept of the university of the future refers to various transformations aimed at modernizing higher education to meet contemporary challenges and future demands (Bakhmat et al., 2024). Many Ukrainian pedagogues correlate the development of university of future and digital transformations (Ivanenko et al., 2024; Potapchuk et al., 2020). They indicate that embracing digital tools and platforms to enhance teaching, learning, and administrative processes. Other works are devoted to formation of professional competence and support continuous education as important precondition of future-oriented educational institution (Tymkiv, 2021).

Importantly, post-war recovery and modernization address the challenges of rebuilding higher education in Ukraine (Bakhmat et al., 2024; Sikora et al., 2023). At present, recent investigations give the great attention to Science, Technology, Engineering and Mathematics (STEM) and Information Technologies (IT) education because it fosters innovation, may help rebuild infrastructure, and drive economic development (Nazarenko et al., 2022; Osadchyi et al., 2024). Therefore, the university of the future aims to create a dynamic, flexible, and innovative higher education system that meets global standards while addressing the unique needs and opportunities within the country (Ivanenko et al., 2024).

Research Focus

The theoretical analysis of the approaches to the development of university of future proves the necessity of clarification of technologies and innovations to enhance the educational process in Ukrainian institutions of higher education. Considering the fact that Ukrainian higher education approximates the European standards through a series of reforms and initiatives guided by the principles of the Bologna Process, Ukraine aims to enhance the quality, relevance, and internationalization of its higher education system. Moreover, the digitalization of higher education is a complicated process that involves integrating digital technologies into various aspects of the education

system. This transformation is driven by the need to modernize teaching and learning methods, and improve access to education.

The connection between digitalization and future-oriented education is obvious, as digital technologies are driving fundamental changes in how the educational process is organized and valued. The university of future aims to prepare students for the challenges and opportunities of tomorrow's world, and pedagogical technologies and innovation play a crucial role in achieving this goal by enabling personalized learning, lifelong learning, formation of professional competences, inclusivity, and integration of emerging tools into the curriculum. Therefore, there is a need to explain the implementation of technologies and innovations within the educational process of the institution of higher education and introduce the university of future that actually represents a paradigm shift from traditional educational models to create a more dynamic and impactful educational environment.

Research Aim and Research Questions

The purpose of the research is to explain technologies and innovations used at the future-oriented university and to outline their impact upon the efficiency of the educational process.

The research addresses the following research questions:

- 1) How is the concept of university of future described by the participants of educational process? What characteristics should it possess?
- 2) What technologies and innovations are integrated into the educational process to make it the future-oriented one?
- 3) How does the use of technologies and innovations shape the educational process at the Ukrainian institutions of higher education?

Literature Review

The university of the future is an institution where technologies and innovations are integrated with traditional educational methods (Ehlers & Eigbrecht, 2024). This includes, among others, the use of AI for adaptive learning, virtual and augmented reality for better learning experiences, and online platforms to make learning schedule more flexible (Mohiuddin et al., 2022). In this regard, the university of future focuses on creating a hybrid model that combines the best of in-person and digital education (Gadhoun, 2022). According to Moral and Villarente (2024), the university of the future prioritizes sustainability and inclusivity, both in its physical infrastructure and its academic programs.

Other findings admit that academic programs at this type of university are designed to break down traditional disciplinary boundaries, encouraging students to engage in problem-solving activities (de Armas-González et al., 2023). The special attention must be paid towards learning through practical, real-world experience to form professional competence as well as readiness to innovation, creativity, and problem-solving (Kong, 2021). The university of the future, as a future-oriented institution, is designed to train professionals who are equipped to work in the rapidly developing landscape. This university emphasizes the development of curriculum that is continuously updated based on emerging trends and technological advancements (Ramírez-Montoya et al., 2021).

A number of recent works are devoted to the study of distinctive characteristics of the university of future apart from the traditional institution of higher education (Carayannis & Morawska-Jancelewicz et al., 2022). First and foremost, it is about technology-enhanced learning (Luik & Taimalu, 2021). The

future-oriented educational process requires the incorporating of AI, virtual reality (VR), augmented reality (AR), online learning, and other emerging technologies to create interactive learning experiences. Personalized learning customizes the education to students' interests and career aspirations, promoting the development of individual educational trajectory (Shemshack & Spector, 2020).

Other characteristics include the following: interdisciplinary programs (Yunus et al., 2024), learning based on practical experience, formation of a culture of lifelong learning (Rosak-Szyrocka et al., 2022), and change or educational discourse (Bhinder, 2023). Additionally, the university of future is characterized by conducting the innovative research that addresses contemporary challenges and drives technological and social modernization (Haukipuro et al., 2024). Definitely, these characteristics collectively define the university of future as a dynamic, responsive, and forward-thinking institution that prepares students to operate successfully in a challenging professional landscape.

The university of future is often related to the smart infrastructure that facilitates innovative teaching, learning, and research, and community engagement (Maciá Pérez et al., 2021). The findings show that the infrastructure components aimed to support advanced technology integration, flexibility, sustainability, and a student-centered approach include smart classroom and technology-enhanced learning space equipped with interactive whiteboards, high-speed internet, and video conferencing capabilities (Pardo-Baldoví et al., 2023); facilities equipped with VR and AR technology for simulations (Zhao et al., 2023); comprehensive Learning Management Systems (LMS) that help to organize a wide range of online learning activities, including course delivery, assessments, discussion forums, and multimedia content (Bradley, 2021). In recent years, more and more scientists insist on development of sustainable infrastructure that minimizes environmental impact, promote resource efficiency (Mykrä, 2023).

According to the recent findings, the university of future applies a number of technological advancements that enhance the efficiency of the educational process (Timotheou et al., 2023). First of all, the scholars consider AI-based technologies an integral part of the future-oriented educational process (Kamalov et al., 2023). Such tools customize learning experiences based on individual student's performance and preferences, as well as provide instant support. AI-driven platforms solve a number of administrative tasks and simplify the routine tasks (George & Wooden, 2023). Also, AI significantly influences analytics by enhancing the ability to process large volumes of data and make data-driven decisions more accurately (Gómez-Pulido et al., 2023).

In education, analytics tools can be used to monitor and analyze student performance data to predict learning outcomes and identify areas for improvement. Other technologies include VR and AR, LMS, and cloud computing (Zhao et al., 2023). Razzaq, Mahar, Qureshi, and Abidin (2020) indicate that IoT creates smart campus infrastructure and help to manage building systems, energy use, and security. Moreover, classrooms and labs equipped with IoT sensors to monitor and enhance the educational environment. Also, blockchain-based systems (Samala et al., 2024) and educational robots (Schiavo et al., 2024), that are becoming increasingly popular in education, will be used to enhance learning experiences and develop essential skills in students at the university of the future.

Besides future-oriented institution is expected to adopt various pedagogical innovations (Budirahayu & Saud, 2023; Nguyen et al., 2022). The scholars emphasize that these innovations should be to focus on creating a more interactive, personalized, and flexible educational process (Bizami et al., 2023). The recent findings show that pedagogical innovations include blended learning, flipped classroom, and personalized learning (Bizami et al., 2023; Chilton et al., 2024). Also, project-based learning demonstrated the high efficiency in formation of professional competence among students (Crespí et al., 2022).

The special attention is paid towards gamification since game-based activities increase engagement, motivation, and retention among students significantly (Zabala-Vargas et al., 2021). It is worth declaring that collaborative learning (Budirahayu & Saud, 2023), microteaching (O'Flaherty et al., 2024), cascade learning (Gökmenoğlu et al., 2021) contribute to transformation of the university into a more dynamic, student-centered environment that prepares future professionals for the challenges of the XXI century.

The role of instructor is undergoing significant changes at the university of the future. Importantly, instructors are not the primary source of knowledge but they act as facilitators of learning, guiding students and helping them develop critical thinking and problem-solving skills (Siljebo & Pettersson, 2022). de Almeida and Viana (2023) show that instructors play a crucial role in designing and adapting curriculum to meet the changing needs of students, incorporating new technologies, interdisciplinary approaches, and real-world applications.

Additionally, instructors focus on advocating personalized learning, collaboration with all the participants of the educational process, and continuous learning to improve their teaching practices (Chanani & Wibowo, 2019; Uy et al., 2024). According to Vietnamese researchers (Hoang Yen et al., 2024), instructors should be aware of a variety of assessment methods performing the role of assessment and feedback provider. This means that teaching at the university of the future is evolving to be more student-centered, technology-driven, and adaptable, focusing on preparing students for success in a complex and rapidly changing world.

Ukrainian institutions of higher education are currently embracing modernization and innovation in teaching, research, and administration (Brovchenko et al., 2023). However, they are facing great difficulties because of full-fledged war in the territory of the country (Galynska & Bilous, 2022), inadequate funding (Zagirniak et al., 2020), and the gap between the skills and knowledge provided by the university and the needs of the labor market (Mospan, 2022). Some report that there are the issues related to outdated curricula, inadequate teaching methods, and a lack of quality assurance mechanisms (Shevchenko, 2019).

This focuses the researchers' attention towards ongoing reforms in the system of higher education, aimed at modernization of institutions of higher education, improving the quality of training, and complying the educational process with the European standards. As the result, the problem of implementation of technological advancements and pedagogical innovations within the educational process and transformation of the traditional institution into the university of future requires the special analysis.

Materials and Methods

To achieve the research, aim and to answer the research questions, the mixed methodology was applied. When studying technologies and innovations at the university of the future, mixed methods appeared to be particularly useful to gain a more comprehensive understanding of a research problem and to reveal both the complexities of technology implementation and their impact on the educational process. Also, the combination of qualitative and quantitative methods helped to explore how technological advancements and pedagogical innovations are implemented at the institution of higher education using the mixed methodology the researchers were able to evaluate the impact of technological advancements and pedagogical innovations on teaching and learning practices and to describe the transformations a traditional institute undergoes to become the university of future.

The application of qualitative and quantitative methods was based on two theoretical approaches: technology acceptance theory (Xue et al., 2024) and diffusion of innovations theory (Frei-Landau et al.,

2022). Technology acceptance approach was used to build the theoretical framework for understanding how the participants of the educational process select, adopt and apply new technologies. It enabled to evaluate technological advancements and their role in establishment of the university of future.

At the same time, diffusion of innovations theory contributed to explanation how a number of pedagogical innovations, including collaborative learning, blended learning, cascade learning, etc., were introduced in teaching and how they improved the educational process. It emphasizes the role of pedagogical innovations and their impact upon the enhancement of the educational process. The integration of these theoretical theories into mixed methodology research provided a deeper understanding of how technologies and innovations are adopted and implemented at the university of the future. In additions, the approaches were used to develop the recommendations for the increasing of professional competence among students within the educational process.

Sample and Participants

The sample included a diverse group of participants who are directly involved into the educational process at the institutions of higher education and are aware of implementation of new technologies and innovations. The study was carried out among faculty members and university administrators in February-April, 2024. 56 faculty members included professors, associate professors, and senior instructors from various disciplines to share their experiences with integrating technology into their teaching practices, as well as the challenges and benefits they face. 12 university administrators provided the current information on policy decisions, strategic planning, and the organizational conditions of implementation of technological advancements and pedagogical innovations at the institution. All the participants provided the informed consent to participate in the research beforehand. Also, the researchers were obliged to protect private information of the participants and ensure that it is not misused.

Instruments and Procedures

Studying technologies and innovations in the educational process involved various instruments to make the research reliable and accurate. Firstly, surveys and questionnaires were used to gather data from faculty members and university administrators about their experiences and attitudes towards the extensive use of technological advances and pedagogical innovations. Secondly, in-depth interviews with the participants provided qualitative data on the impact of technologies and innovations upon the enhancement of educational process and their role in transforming the traditional institution of higher education.

Thirdly, observational studies were used to see how technologies and pedagogical innovations are introduced in the classroom and how educational environment changes when teaching practices become technology-enhanced or interactive. Fourthly, content analysis of methodological documents and educational materials provide the data on the adopted algorithm of introduction of a number technological advancement and pedagogical innovations in the educational process. Fifthly, ethnographic and pedagogical method was applied to demonstrate the specifications of the educational process at the Ukrainian institutions of higher education and to present the approaches to building of efficient educational environment during war.

Data Analysis

In mixed methodology research, data analysis involved both qualitative and quantitative data to provide accurate outcomes. Quantitatively, the following methods were used: descriptive statistics and multivariate analysis. Descriptive statistics enabled to summarize and describe the main features of the

university of future. Also, the method contributed to the analysis of the frequency of using technological advancement and pedagogical innovations in the educational process. Multivariate analysis, particularly component analysis, helped to understand the relationships between the implementation of technological advancement and pedagogical innovations within the educational process and modernization of the institution of higher education.

Besides, some qualitative data analysis methods were used such as thematic analysis and narrative analysis. For instance, thematic analysis involved identifying, analyzing, and making conclusions on the basis of qualitative data. It helped to understand key concepts and patterns from surveys, interviews, and observations. Narrative analysis was useful to focus on the personal experiences of the participants who analyzed the peculiarities of technological advancement and pedagogical innovations which were implemented within the educational process.

Results

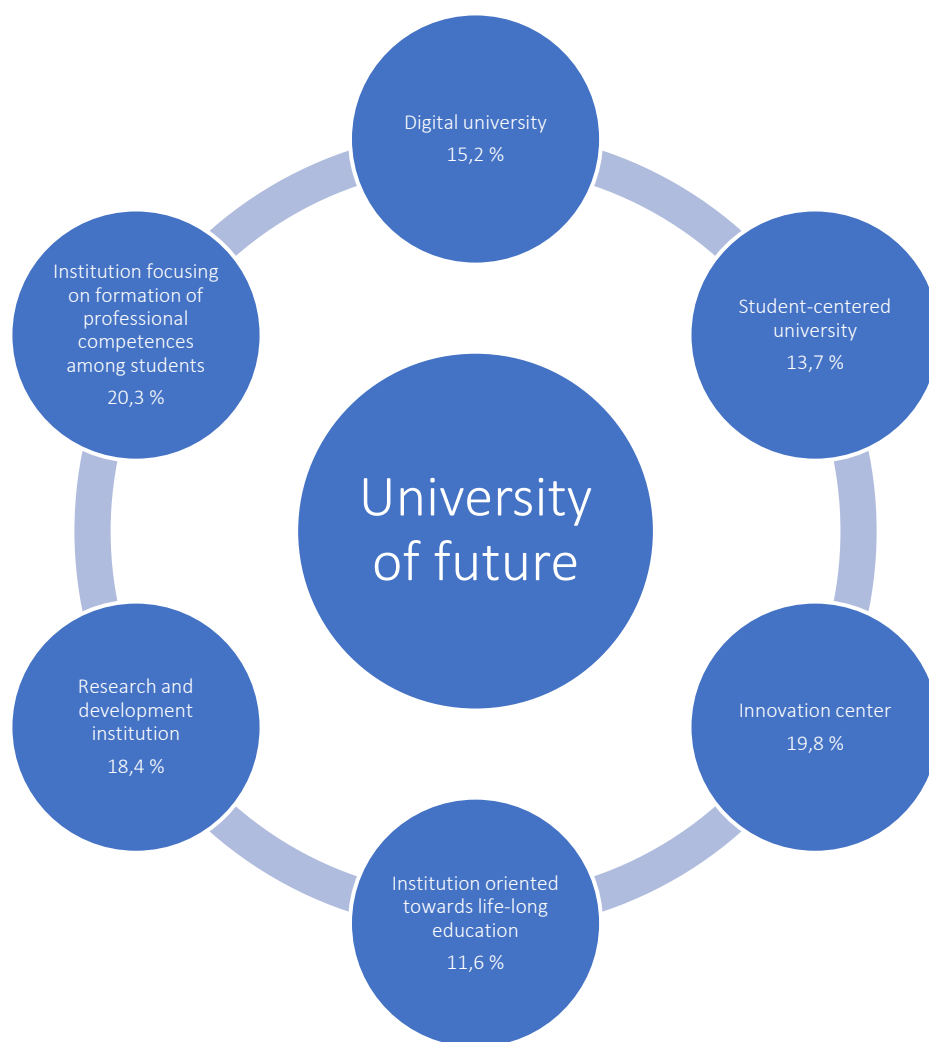
Description of the concept of university of future and its characteristics

The results showed that the participants understand the concept of university of future differently. The biggest number (20,3 %) of instructors and university administrators think that the university of future is the institution focusing on the formation of professional competences among students through the use of innovative techniques. At the same time, 19,8 % of participants consider the university of future to be the innovation center where innovation and entrepreneurship are actively supported and where different programs of partnerships with industry are introduced.

At the innovation center different topical researches are conducted to study the problems of sustainability of higher education. 18,4 % of instructors and university administrators suppose the university of future to be research and development institution to provide innovative development in the sphere of industry and higher education. Other interpretations relate to digital university (15,2 %), student-centered university (13,7 %), and institution oriented towards life-long education among future professionals (11,6 %). Figure 1 shows that different interpretation of the concept of university among the survey participants.

Figure 1

Interpretation of the concept of the university of future



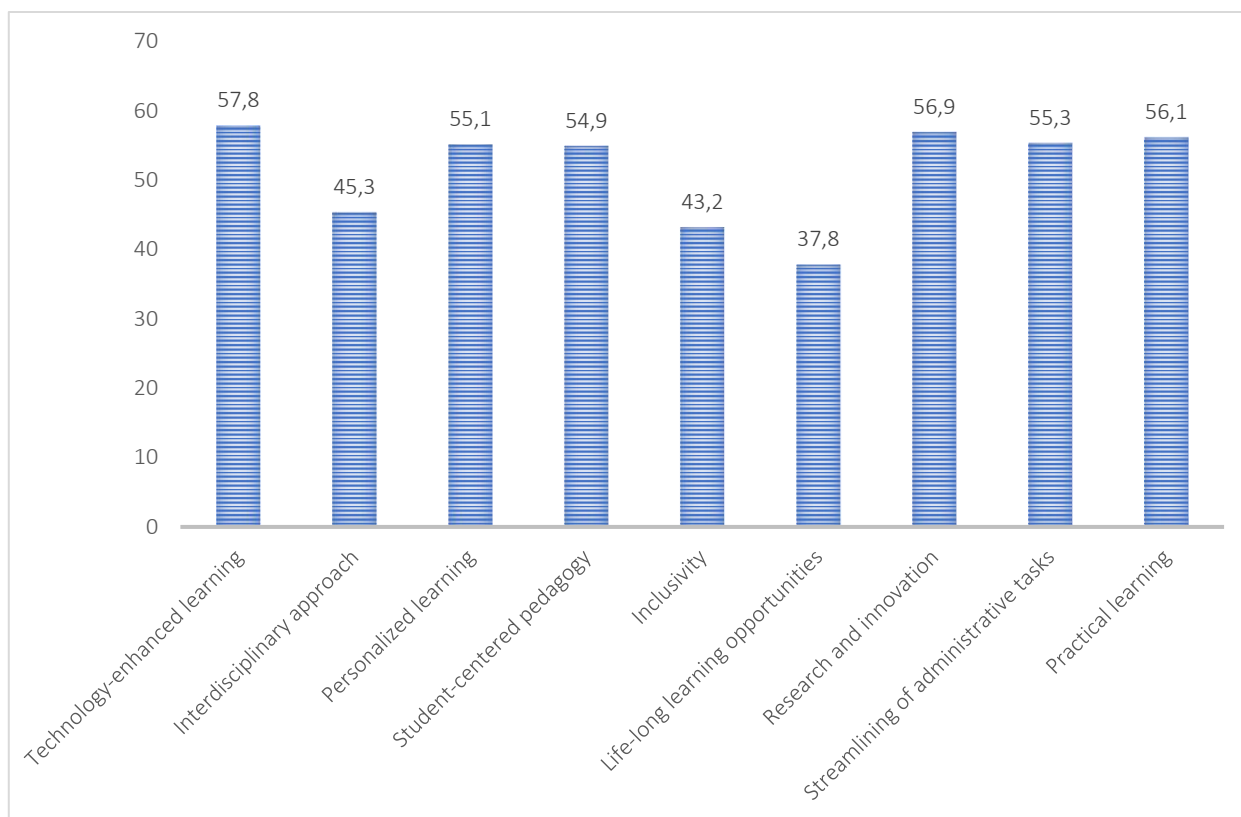
Source: Authors' development.

At the same time, the research was aimed at outlining the unique characteristics of university of future. According to the in-depth interviews, the concept is understood through various unique characteristics that reflect advancements in technology and pedagogy addressing the needs of a rapidly changing world. Thus, 57,8 % of participants name technology-enhanced learning as the main characteristic of university of future since their advanced technologies such as AI, VR, AR, and learning analytics are used to enhance the efficiency of the educational process. 56,9 % of instructors and university administrators focus on research and innovation. It means that the main function of the university of future is to act as a center for important research and innovation to drive the society progress. 56,1 % of respondents are aware that the university of future require concentration on practical learning to form professional competences among students.

Other characteristics concern interdisciplinary approach, personalized learning, student-centered pedagogy, life-long learning opportunities, and streamlining of administrative tasks through innovative tools. The special attention was paid towards inclusivity since it is considered that the university of future must ensure accessibility for all students, providing resources and support for diverse populations, including those with disabilities and from underrepresented backgrounds. In the Ukrainian context, the instructors and must university workers must be aware that a number of students come from war-affected areas and suffer from post-traumatic stress disorder. Figure 2 demonstrates the unique characteristics the university of future possesses.

Figure 2

The characteristics of university of future



Source: Authors' development.

Integration of technologies and innovations into the educational process to create the future-oriented university

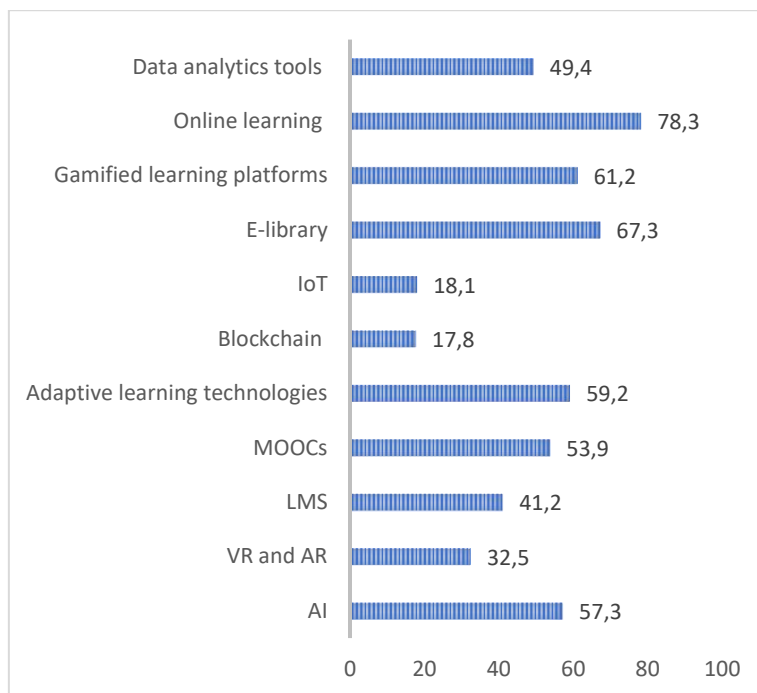
Studying the integration of technologies and innovations into the educational process to create the future-oriented university, we conducted two questionnaires on the use of technological advancements and pedagogical innovations by instructors and university administrators. It was found that technological advancements include online learning (78,3 %), e-library (67,3 %), gamified learning platforms (61,2 %), adaptive learning technologies (59,2 %), AI tools (57,3 %), Massive Online Open Courses (MOOCs) (53,9 %), data analytics tools (49,4 %), LMS (41,2 %), VR and AR (32,5 %). The respondents' answers showed that data analytics tools are used to analyze students' performance, learning behaviors, and institutional data. At the same time, AI-based tools are used for personalized learning, predictive analytics, automated grading, and virtual teaching assistants. VR and AR provide effective learning experiences, allowing students to explore complex subjects in the virtual environment using simulations. LMS platforms facilitate course management, content delivery, and student engagement.

At the same time, MOOCs offer multimedia self-paced courses to expand educational opportunities and provide additional educational materials for students. Adaptive learning systems use data to tailor learning experiences to individual students' needs, adjusting the educational content. E-libraries offer easy access to textbooks, research papers, and academic journals, supporting remote learning and

research. And gamified learning platforms incorporate game elements to motivate and engage students within the educational process. Also, it was found that a comparatively small number of participants apply IoT (18,1 %) and blockchain (17,8 %) because these technologies require advanced training and improved university infrastructure. Figure 3 shows the use of technological advancements to create the university of future.

Figure 3

The use of technological advancements at the university of future

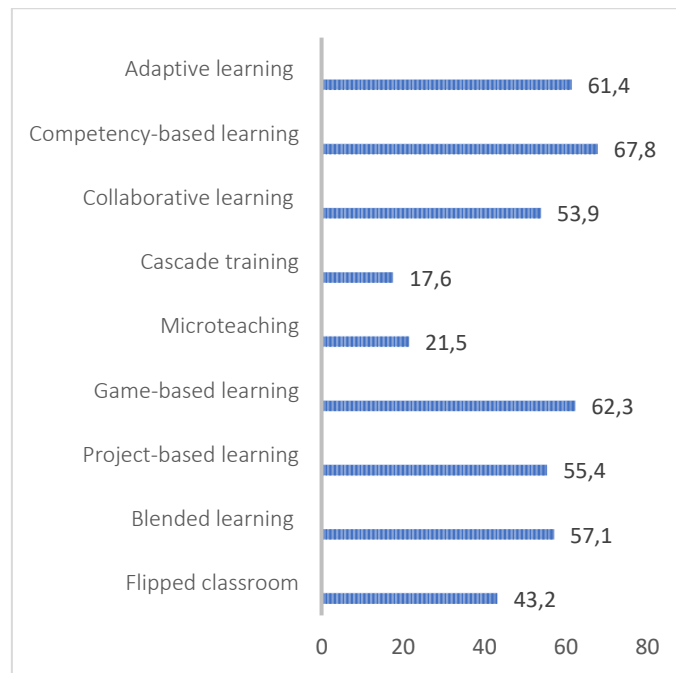


Source: Authors' development.

Also, the comprehensive analysis was conducted on the basis of questionnaire, interviews and observations to reveal pedagogical innovations used within the educational process. The biggest number of faculty members and university administrators (67,8 %) consider that competence-based approach oriented towards preparation of students to future professional activities and, therefore, it is integral pedagogical innovation within the educational process at the future-oriented university. Other pedagogical innovations include game-based learning (62,3 %), adaptive learning (61,4 %), blended learning (57,1 %), project-based learning (55,4 %), collaborative learning (53,9 %), and flipped classroom (43,2 %).

Figure 4

The use of pedagogical innovation within the educational process



Source: Authors' development.

According to the answers and observation reports, it was discovered that adaptive learning helps to adjust the type of content based on individual students' performance, providing a personalized learning experience. At the same time, gamification integrates various games within the curriculum and increases the engagement significantly. Blended learning is mainly used to combine online learning with traditional face-to-face classroom methods. It provided the flexible educational process and help to enhance its efficiency.

Additionally, flipped classroom changes traditional teaching delivering the educational materials online outside of class and using classroom time for interactive, practice-based activities. Interactive pedagogical innovations like project-based learning and collaborative learning increase students' engagement through active work and solving professional problems. Only 21,5 % participants use microteaching, and 17,6 % - cascade training. But despite of these numbers, the respondents consider these pedagogical innovations help to develop essential professional competence among students and motivate them to future professional activity. Figure 4 present the integration of pedagogical innovations within the educational process of the future-oriented institution.

The use of technologies and innovations to shape the educational process at the Ukrainian institutions of higher education

The peculiarities of using technological advancement and pedagogical innovations were studied during the experimental research as well. It was noticed that various tools and teaching techniques are implemented through organizational and pedagogical measures. The respondents' answers testify that organizational measures include establishment of clear objectives within the educational process, introduction of clear regulation of their use, providing comprehensive training for faculty members and university administrators, establishment of a secure network infrastructure, and integration of these tools within the university platforms.

At the same time, pedagogical measures related to the use of certain teaching methods, development of high-quality educational materials, increasing students' motivation, and introduction of effective assessment techniques. Table 1 shows the analysis of implementation of technological advancements and pedagogical innovations within the educational process of the future-oriented

institution on the basis of participants' perceptions. The following measures may facilitate the introduction of technological advancements and pedagogical innovations and result in acceleration of the transformation of the institution of higher education into a future-oriented one.

Table 1

Implementation of technological advancements and pedagogical innovations within the educational process

Technologies and innovations	Implementation
The use of technological advancements	
Data analytics tools	Establishment of clear objectives; Availability of the necessary hardware and software to support data analytics operations; Providing the systematic collection of high-quality data from various sources; Introduction of data privacy regulations.
Online learning	Implementation of a LMS that supports course delivery, communication, and assessment; Creation of engaging, interactive, and practice-oriented online courses; Development and integration of multimedia resources; Providing comprehensive training for faculty members on online teaching strategies.
Gamified learning platforms	Providing the options for students to personalize their learning; Establishment of immediate feedback; Design of the assessments that measure students' performance and progress within the gamified framework.
e-library	Implementation of library management system or digital library platform to organize and manage digital resources; Design of a user-friendly interface that allows easy navigation and search functionalities; Ensuring the accuracy and completeness of metadata to enhance the discoverability of digital resources.
IoT	Establishment of a secure network infrastructure; Using data processing techniques; Integration of IoT data with existing information technologies systems.

Blockchain	<p>Ensuring data privacy and confidentiality;</p> <p>Development of policies and guidelines for the use of blockchain in higher education;</p> <p>Provide training and awareness programs for faculty members.</p>
Adaptive learning technologies	<p>Design of personalized learning paths for students;</p> <p>Selection and development of an adaptive learning platform that can analyze student data and deliver personalized content;</p> <p>Implementation of the mechanisms to collect and analyze data on students' interactions, performance, and progress;</p> <p>Integration of the adaptive learning platform with existing LMS.</p>
MOOCs	<p>Design of interactive and engaging learning activities to promote active learning and student participation;</p> <p>Development of effective assessment methods.</p>
LMS	<p>Ensuring that the LMS can integrate with existing systems;</p> <p>Organization of the course content in a logical and structured manner;</p> <p>Implementation of the security measures to protect user data;</p> <p>Integration with interactive tools;</p> <p>Collection of feedback from users.</p>
VR and AR	<p>Development of interactive educational content;</p> <p>Creation of scenario-based learning experiences;</p> <p>Development of effective assessment methods;</p> <p>Providing technical support for faculty members.</p>
AI	<p>Selection or development of AI tools that meet the institution's needs and objectives;</p> <p>Design of AI-powered learning experiences that adapt to individual students' needs and preferences;</p> <p>Offering the orientation sessions for students to familiarize them with AI tools;</p> <p>Development of the policies and guidelines for the ethical use of AI in teaching, learning, and administration.</p>
Pedagogical innovations	
Adaptive learning	Offering differentiated instruction;

	<p>Design of interactive and engaging learning content;</p> <p>Incorporation of gamification elements.</p>
Competence-based learning	<p>Mapping competences to courses and learning activities;</p> <p>Integration of competences development into the curriculum;</p> <p>Using performance-based assessment methods.</p>
Collaborative learning	<p>Formation of groups with diverse backgrounds, skills, and perspectives;</p> <p>Assignment of tasks that require students to work together to solve complex problems or complete projects;</p> <p>Using case studies that require students to analyze and discuss real-world scenarios collaboratively.</p>
Cascade training	<p>Ensuring that participants are motivated and committed to training;</p> <p>Using an interactive approach to teaching;</p> <p>Assessment of the impact of the training on both student-trainer and student-trainee.</p>
Microteaching	<p>Appropriate lesson planning;</p> <p>Encouragement of participants to use a variety of teaching strategies;</p> <p>Encouragement of participants to observe and provide feedback to their peers;</p> <p>Using video recording to capture microteaching sessions.</p>
Game-based learning	<p>Designing games that are engaging, interactive, and challenging;</p> <p>Integration of game-based learning activities into the curriculum;</p> <p>Ensuring that the games are relevant to the course content.</p>
Blended learning	<p>Integration of online and face-to-face components;</p> <p>Using a variety of instructional strategies and resources to engage students;</p> <p>Promotion of active learning and student engagement through interactive online activities, group work, and discussions;</p> <p>Development of effective assessment strategies.</p>
Flipped classroom	<p>Using technology to deliver pre-class materials and facilitate online discussions;</p> <p>Offering support and additional resources;</p> <p>Encouragement of students to reflect on their learning experiences.</p>
Project-based learning	<p>Designing the projects that are engaging and meaningful;</p>

Encouragement of collaboration among students;

Using technology to support project-based learning, such as online collaboration tools, multimedia presentations, and research databases;

Encouragement of students to present their projects to external audiences

Source: Authors' development.

Therefore, it is necessary to admit the technological advancements and pedagogical innovations potentially bring significant changes within the educational process. They enhance the educational process significantly that leads to formation of professional competences among students, their preparation for future professional activity, and increase their motivation to learning. Since there are a number of technological advancements and pedagogical innovations, the faculty members and university administrators must be aware of the selection of the most efficient ones when planning the educational activity or designing the curriculum. Definitely, the adequate use of technological advancements and pedagogical innovations facilitate transformation of the traditional Ukrainian institution of higher education into future-oriented one and approximate it to the European standards.

Discussion

The research was oriented towards the explanation of technologies and innovations used at the future-oriented university and the outlining their impact upon the efficiency of the educational process. The findings show that technological transformations of the educational process nearly always lead to its enhancement and increase students' performance (Bakhmat et al., 2024). Since a number of technological advancements and pedagogical innovations are implemented within the educational process, they change the educational landscape significantly and facilitate the creation of the educational institution of new type that is often called the university of future (Ehlers & Eigbrecht, 2024; Haukipuro et al., 2024).

The literature analysis of different approaches to defining the concept of university of future showed that it is interpreted as an institution where technologies and innovations are integrated with traditional educational methods (Ehlers & Eigbrecht, 2024). Other scholars admit that the university of future used AI-driven technologies, VR and AR tools, and deliver the educational materials through online platforms (Díaz-García et al., 2022; Mohiuddin et al., 2022). A number of findings connect the concept of university of future with digitalization and informatization of the educational process (Gadhoun, 2022; Ivanenko et al., 2024; Potapchuk et al., 2020). At the same time, the recent findings demonstrate that the university of future must possess certain characteristics. These characteristics refer to hybrid model of learning (Gadhoun, 2022), sustainability and inclusivity (Moral & Villarente 2024), interdisciplinary curriculum (de-Armas-González et al., 2023), and practice-based learning (Kong, 2021).

At the same time, the survey demonstrated that the participants of the educational process understand the university of future as an institution focusing on the formation of professional competences among students through the use of innovative techniques. Also, it is referred as an innovation center, research and development institution, digital university or student-centered university. The special attention was paid towards the analysis of the characteristics of the university of future. According to the respondents, they included technology-enhanced learning, research and innovation. It means that the main function of the university of future is to act as a center for important research and innovation, practical learning, interdisciplinary approach, personalized learning, student-

centered pedagogy, life-long learning opportunities, and streamlining of administrative tasks through innovative tools.

Presently, a number of researchers study the integration of technologies and innovations into the educational process. It was found that AI-based technologies (Kamalov et al., 2023; George & Wooden, 2023), VR and AR, LMS, and cloud computing (Zhao et al., 2023) enhance the educational process significantly. Other technological advancements are IoT (Razzaq et al., 2020), blockchain-based systems (Samala et al., 2024) and educational robots (Schiavo et al., 2024). In the context of studying of pedagogical innovations, we discovered that they primarily focus on creating more flexible educational process (Bizami et al., 2023). The literature review showed that the university of future implements blended learning, flipped classroom, and personalized learning (Chilton et al., 2024), project-based (Crespí et al., 2022), and gamification (Zabala-Vargas et al., 2021). Some authors describe the use of collaborative learning (Pozzi et al., 2023), microteaching (O'Flaherty et al., 2024), and cascade learning (Gökmenoğlu et al., 2021).

Similar results were shown during the analysis of faculty members and university administrators' answers. But it is worth mentioning that the biggest number of universities apply competence-based approach, game-based learning, and adaptive learning. At the same time, microteaching and cascade training are used only sporadically for specific purposes. In some cases, these pedagogical innovations are used in the schemes of long-life education to organize the advanced training of teaching professionals or postgraduate students who are aware of teaching practices themselves.

Studying the implementation of technological advancements and pedagogical innovations, it was revealed that an instructor chooses the most efficient techniques contributing to the enhancement of the educational process. In this regard, the role of instructor is changing nowadays, and faculty members perform functions of facilitators (Siljebo & Pettersson, 2022), curriculum designers (de Almeida & Viana, 2023), and innovators (Chanani & Wibowo, 2019). The special attention was paid towards the using of technological advancements and pedagogical innovations for assessment of students' performance (Hoang Yen et al., 2024).

It is worth mentioning that according to faculty members and university administrators, implementation of technological advancements and pedagogical innovations require using organizational and pedagogical measures. Organizational measures are related to improvement of infrastructure, introduction of clear regulation. Also, the respondents insist that comprehensive training are important to train the individuals to using the instruments within the educational process. Pedagogical measures include teaching methods, high-quality educational materials, and effective assessment techniques. The findings showed that the implementation of the following measures may contribute to acceleration of the positive transformations of the educational process and creation of the future-oriented university.

Conclusions and Implications

The research demonstrated that the university of the future refers to a forward-thinking, innovative educational institution that implements the latest advancements in technology and pedagogy to provide an enhanced learning experience. The concept has evolved over time and influenced by rapid technological advancements, changes in workforce demands, and changes in educational paradigms. The findings devoted to the distinctive characteristics of the university of future showed that it requires technology-enhanced learning and incorporating of advanced technologies such as AI, VR, AR, and online learning. Besides, the university of future is characterized by personalized learning, using of interdisciplinary programs, practice-based learning, formation of culture of lifelong learning. It was

revealed that the university of the future is often associated with the smart infrastructure that facilitates innovative teaching, learning, and research, and community engagement.

Regarding Ukrainian institutions of higher education, they are currently embracing modernization and innovation in teaching, research, and administration. Many Ukrainian scholars correlate the development of university of future and digital transformations. Some of them indicate that formation of professional competence and support continuous education as important precondition of future-oriented educational institution. But the institutions in Ukraine are facing great difficulties because of full-fledged war in the territory of the country, inadequate funding, and the gap between the skills and knowledge provided by the university and the needs of the labor market. It was concluded that the problem of implementation of technological advancements and pedagogical innovations within the educational process and transformation of the traditional institution into the university of future is very important to modernize the Ukrainian system of higher education.

The university of the future applies a number of technological advancements that enhance the efficiency of the educational process. They include AI-based technologies, VR and AR, LMS, and cloud computing. Some works emphasize the using of IoT, blockchain-based systems and educational robots. The pedagogical innovations are related to blended learning, flipped classroom, and personalized learning. Some findings suggest that project-based learning, game-based activities, and collaborative learning are extensively used at the future-focused institutions and help to transform the traditional educational process into a more dynamic and student-centered one.

The special attention was paid towards the implementation of technological advances and pedagogical innovations. It was discovered that educational tools and teaching techniques are implemented through organizational and pedagogical measures. Organizational measures include establishment of clear objectives within the educational process, introduction of clear regulation of their use, providing comprehensive training for faculty members and university administrators, establishment of a secure network infrastructure, and integration of these tools within the university platforms. At the same time, pedagogical measures related to the use of certain teaching methods, development of high-quality educational materials, increasing students' motivation, and introduction of effective assessment techniques.

The findings can be implemented across various educational contexts to enhance teaching and learning practices. Firstly, technological advancements and pedagogical innovations will be used to improve classroom activities at the different levels of higher education. Secondly, in they may be implied to develop professional training programs and lifelong learning initiatives through online workshops and adaptive learning platforms to continuously retrain professional in different skills. Thirdly, and most important, the concept of university of future will facilitate the post-war restoration of the Ukrainian system of higher education.

Suggestions for Future Research

Further research should be focused several aspects. One suggestion is to investigate the integration of AI in personalized learning environments at the Ukrainian institutions of higher education and to develop the methodological principle of building the individual educational trajectory by means of AI-driven tools. Additionally, research should be concentrated on the evaluation of the efficiency of VR and AR when forming the professional competences among students. Future studies should also analyze the emerging trends within the educational process and prepare the guidelines to adapt the Ukrainian universities to new challenges and possibilities. Furthermore, exploring the potential of blockchain technology, educational robotics, and IoT are not fully discovered in Ukraine. The analysis of these technological advances is essential due to the transformative potential these technologies for

improving educational practices, enhancing learning experiences, and preparing students for future careers. For instance, blockchain offers a decentralized and secure way to manage and verify academic data, ensuring that records are secure and easily accessible.

By studying blockchain, educational institutions can develop advanced databases systems facilitating new methods of managing students' records. The integration of IoT in education can create smart classrooms where devices and sensors enhance the learning environment. Also, IoT can be used to monitor classroom conditions, automate administrative tasks, and personalize learning experiences. Additionally, robotics is crucial for developing problem-solving skills, creativity, and technical knowledge among students. As robots become more prevalent in various industries, equipping students with the skills to design, program, and interact with robots prepares them for future professional activity. It is worth mentioning that future research should reveal the peculiarities of using IoT, blockchain-based technologies, and educational robotics in the Ukrainian landscape.

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