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Innovative Educational Technologies in University Settings

Iryna Barbashova[1,*], Liudmyla Hetmanenko[2], Oksana Kukhniuk[3], Iryna Vasylenko[4] and Olena Snisar[5]
[1]Doctor of Pedagogical Sciences, Professor, Professor of Department of Pedagogy, Faculty of Psychological and Pedagogical Education and Arts, Berdyansk State Pedagogical University, Zaporizhzhya, Ukraine.
[2]Senior Lecturer of the Department of Natural Sciences and Mathematics Education and Technologies, Institute of In-Service Teachers' Training, Borys Grinchenko Kyiv Metropolitan University, Kyiv, Ukraine.
[3]PhD, Head of the Department of Pharmaceutical Disciplines of Cherkasy Medical Academy, Cherkasy, Ukraine.
[4]PhD in Pedagogy, Head of the Department of Fundamental Disciplines of Cherkasy Medical Academy, Cherkasy, Ukraine.
[5]Candidate of Pedagogical Sciences, Head of the Department of Natural Sciences of Cherkasy Medical Academy, Cherkasy, Ukraine.

Corresponding authors: (e-mail: i.a.barbashova@gmail.com).

Abstract The implementation of modern technologies in the educational process of higher education institutions is becoming increasingly relevant in the context of the digitalisation of society and the need to improve the quality of education. Applying technologies such as e-learning, blended learning, mobile learning, and artificial intelligence requires careful examination of their impact on the educational process and students' professional competencies. The study aims to analyse and evaluate the effectiveness of modern teaching technologies in higher education institutions. The object of the study includes various forms and methods of using digital technologies in the educational process. The research methodology involves analysing and synthesising existing data, comparative analysis of different technologies, modelling educational processes, and classifying technologies based on their characteristics and application areas. The study results showed that using modern teaching technologies significantly improves the quality of education, enhances student performance, and develops professional competencies. Blended learning and mobile technologies provide flexibility and accessibility to the educational process, which is especially important in the context of distance learning. Artificial intelligence allows the personalisation of the learning process by adapting it to the individual needs of each student. Cloud technologies facilitate collaborative work and access to educational materials, enhancing interaction between students and teachers. The practical significance of the research results lies in developing recommendations for the optimal implementation and use of modern teaching technologies, which will improve the efficiency of the educational process and student preparation for professional activities.

Index Terms modern teaching technologies, higher education, e-learning, blended learning, mobile learning, artificial intelligence, cloud technologies, personalised learning, educational process, professional competencies

I. Introduction

The rapid development of technology in the world significantly affects all spheres of life, including education. Higher education requires the implementation of the latest technologies to ensure high-quality education, increase knowledge accessibility, and develop students' professional competencies. These changes necessitate the study and analysis of modern teaching technologies used in higher education institutions and the evaluation of their impact on the quality of the educational process. An analysis of recent research and publications shows significant interest in using modern technologies in higher education. For instance, Amenduni and Ligorio [1] emphasise integrating different learning formats to enhance education quality, exploring international perspectives on blended learning. Mirajkar [2] highlights the need for implementing blended learning in higher education, pointing to its role in providing flexibility and accessibility for students.

Similarly, Stepanova [3] examines the implementation of blended learning in universities, stressing its advantages and challenges. The widespread use of artificial intelligence and machine learning opens new horizons for personalisation and increases the efficiency of the learning process. Thus, modern teaching technologies are crucial in transforming the educational process in higher education institutions, contributing to its quality, accessibility, and individualisation.

II. Problem Statement

Higher education is also undergoing significant changes in the context of rapid technological development and its comprehensive impact on various spheres of human activity. Traditional teaching methods need to be revised to meet modern educational needs. It creates the necessity to implement modern technologies that can significantly enhance the quality of the educational process, making it more accessible and adaptable to students' individual needs. Modern technologies, such as e-learning, blended learning, mobile learning

(m-learning), massive open online courses (MOOCs), gamification of the educational process, virtual and augmented reality (VR/AR), artificial intelligence (AI), and cloud technologies, open new opportunities for improving the learning process. However, implementing these technologies comes with several challenges, such as the need for significant investments, teacher training, adaptation of curricula, and overcoming technical difficulties. The problem is that despite the significant potential of modern technologies to improve the quality of higher education, their implementation requires careful analysis, planning, and evaluation. It is necessary to identify which technologies integrate most effectively into the learning process, how they impact student performance and professional competencies, and what risks and limitations accompany their application. Thus, the research and analysis of modern teaching technologies in higher education institutions and evaluating their impact on the quality of the educational process become relevant tasks.

This article aims to research and analyse modern teaching technologies used in higher education institutions and assess their impact on the quality of the educational process and the development of students' professional competencies.

A. Objectives

1) To review modern teaching technologies used in higher education institutions.
2) To identify the advantages and disadvantages of different learning technologies in higher education.
3) To evaluate the impact of the introduction of modern technologies on the quality of the educational process and the level of students' knowledge.
4) To analyse the experience of using modern teaching technologies in leading higher education institutions.
5) To develop recommendations for the optimal implementation and use of modern teaching technologies in the educational process of higher education institutions.

III. Recent Research and Publication Analysis

A. Blended learning technologies

Blended learning combines traditional teaching methods with online technologies, enhancing the efficiency of the educational process. Amenduni & Ligorio [1] explore international perspectives on blended learning, emphasising the importance of integrating different learning formats to improve education quality. Mirajkar [2] points out the necessity of blended learning in higher education, highlighting its role in providing flexibility and accessibility for students. Stepanova [3] examines the implementation of blended learning in universities, focusing on its advantages and challenges. Batsurovska [4] describes a technological model for training master's students using blended learning to enhance professional competence. A study the adoption of mobile learning technologies in a blended format, emphasising the importance of mobile technologies. Horbatiuk [5] analyses interactive learning technologies in higher education institutions, which are critical components of blended learning. Reigeluth [6] critically examines MOOCs as an element of blended learning, highlighting their role in addressing higher education crises. Bilow [7] investigates the role of artificial intelligence and machine learning in blended learning, focusing on personalising the educational process. Thus, blended learning demonstrates significant potential in enhancing the quality of higher education by integrating traditional and innovative approaches [8].

B. Use of mobile technologies in education

Mobile technologies open new learning opportunities, making it more accessible and interactive. El-Sofany & El-Haggar [9] explore the effectiveness of mobile learning in higher education, emphasising its impact on improving learning outcomes. Kustandi et al. (2020) describe the use of VR in online learning, highlighting the role of mobile devices in this process. Ullah et al. [10] investigate the impact of e-learning on higher education, particularly the role of mobile technologies. Sokhina et al. [11] consider the prospects of cloud technologies in higher education, emphasising their mobile aspects. Tayirova [12] studies the possibilities of using cloud technologies in the higher education system, focusing on mobile access. Al Masarweh & Afandi [13] investigate the factors influencing the adoption of mobile learning by distance learning students. Swiontek et al. [14] analyse the use of machine learning in higher education, particularly its mobile applications. Horbatiuk [5] examines interactive learning technologies, including mobile platforms. Mobile technologies are becoming an essential component of modern higher education, ensuring the accessibility and interactivity of the learning process.

C. Use of artificial intelligence and machine learning

Artificial intelligence and machine learning open new horizons for the personalisation and efficiency of the educational process. Bilow [7] examines the use of artificial intelligence and machine learning in higher education, emphasising their potential. Stepanova [3] investigates the role of blended learning, which utilises artificial intelligence technologies. Swiontek et al. [14] describe the application of machine learning in higher education, focusing on its capabilities for adaptive learning. Vergara et al. [15] explore player profiles in higher education using gamification elements and artificial intelligence. Soloviev et al. [16] describe the technology of using 3D models in laboratory work with the application of artificial intelligence. Sokhina et al. [11] consider the prospects of cloud technologies, including artificial intelligence, in higher education. Reigeluth [6] critically examines MOOCs, highlighting their role in addressing higher education crises using AI. The use of artificial intelligence and machine learning significantly enhances the possibilities for personalised learning and improves the efficiency of the educational process.

D. Cloud technologies in higher education

Cloud technologies provide new opportunities for storing, sharing, and accessing educational materials in higher edu-

cation. Sokhina et al. [11] consider the prospects of cloud technologies in higher education, emphasising their potential for collaborative work. Tayirova [12] explores the possibilities of using cloud technologies in the higher education system, particularly for distance learning. Soloviev et al. [16] describe the technology of using 3D models in laboratory work with cloud platforms. Parusheva et al. [17] investigate sustainable development in higher education by implementing cloud technologies. Poliak [18] describes modern mobile information tools for learning in higher education institutions, including cloud technologies. Riznyk (2021) examines the use of multimedia technologies during distance learning in higher education institutions with a focus on cloud platforms. Pyzh & Halenko [19] consider the conditions for implementing information technologies in higher education institutions using cloud services. El-Sofany, & El-Haggar [9] study the effectiveness of mobile learning using cloud technologies in higher education. Cloud technologies are becoming an integral part of the modern learning process in higher education institutions, ensuring the flexibility and accessibility of educational resources.

IV. Research Methods

1) Analysis and synthesis. This method includes breaking down the phenomenon under study into its components (analysis) and combining them into a coherent whole (synthesis). In this article's context, analysis helps identify critical components and aspects of modern learning technologies, such as e-learning, blended learning, mobile learning, and others. Synthesis integrates the acquired knowledge into a general picture, forming a holistic understanding of the impact of these technologies on the educational process in higher education institutions.
2) Comparative method. This method is used to identify similarities and differences between various learning technologies and their applications in higher education institutions. This article makes comparisons based on criteria such as improving student performance, increasing motivation to learn, and accessibility of educational resources. This method allows for assessing the effectiveness and suitability of different technologies in various educational contexts. The comparative analysis results will help identify the most effective and promising learning technologies.
3) Modelling. The modelling method involves creating abstract models that represent simplified versions of actual educational processes using modern technologies. In this article, modelling helps predict possible implementation outcomes and assess their impact on the educational process. This method helps to visualise and understand the complex interrelationships between different elements of the educational system. Based on the models, recommendations are developed for the optimal implementation of technologies.
4) Classification. The classification method involves systematising and organising different learning technologies based on specific criteria and characteristics. In this article, classification allows structuring knowledge about modern learning technologies, highlighting their key features and areas of application. This method helps to understand better the diversity of existing technologies and their potential for use in higher education. The classification results can be used to develop curricula and strategies for implementing technologies in the educational process.

V. Research Results

Modern learning technologies are crucial in transforming the educational process in higher education institutions. They contribute to improving education quality, increasing accessibility, and individualising the learning process. It is necessary to consider the main ones:

A. Electronic Learning (e-learning)

E-learning includes using various digital platforms and online resources to conduct classes, tests, assessments, and feedback. Platforms like Moodle, Blackboard, and Canvas allow teachers to create interactive courses that students can complete at their convenience [20].

B. Blended Learning

Blended learning combines traditional classroom-based instruction with online components. It allows students to acquire theoretical knowledge through online lectures and practice in class under the guidance of a teacher. This model promotes a more profound understanding of the material.

C. Mobile Learning (m-learning)

Mobile learning uses mobile devices (smartphones, tablets) to access educational materials, complete assignments, and communicate with teachers and peers. It allows learning at any time and place, especially relevant for students who combine studies with work.

D. Massive Open Online Courses (MOOCs)

MOOCs provide access to courses from leading universities worldwide via the Internet. Platforms like Coursera, edX, and FutureLearn allow students to study various disciplines and receive certificates upon completion, enhancing their competitiveness in the job market [21].

E. Game-Based Learning (Gamification)

Gamification includes using game elements (points, levels, rewards) in educational processes to increase motivation and student engagement [22]. Examples include platforms like Kahoot! and Quizlet, which turn the learning process into an exciting game [23], [24].

F. Virtual and Augmented Reality (VR/AR)

Ttechnologies enable the creation of interactive 3D models and simulations that students can study and interact with.

This is beneficial in fields such as medicine, engineering, and architecture.

G. Artificial Intelligence (AI)

AI and machine learning are used to create adaptive learning systems that adjust to each student's needs and knowledge levels. This allows for creating personalised learning programs and improves the assessment process.

Cloud Technologies. Cloud technologies provide access to educational materials, software, and resources via the Internet, facilitating collaboration, information sharing, and data storage. Tools like Google Drive, Dropbox, and OneDrive are popular in education [25].

Using these technologies in higher education institutions contributes to creating a more flexible, interactive, and accessible educational process, ultimately improving the quality of education and preparing students for professional activities.

The advantages and disadvantages of different learning technologies in higher education are presented in Table 1.

Modern learning technologies significantly transform the educational process in higher education institutions by offering various tools and methods that enhance learning efficiency. Despite certain drawbacks, the prudent use of these technologies can significantly improve the accessibility and quality of education. It is essential to consider both the advantages and potential risks when implementing new technologies in the learning process. Higher education institutions can adapt their teaching approaches to make the most effective use of modern technological opportunities [26].

Integrating modern technologies into the educational process enhances the interactivity and personalisation of learning, positively affecting student engagement levels. Technologies such as e-learning and mobile applications ensure access to high-quality educational materials and allow students to study conveniently. Figure 1 presents the dynamics and statistical data on implementing modern technologies in higher education from 2018 to 2023.

The graph presents the dynamics of various indicators of the implementation of modern educational technologies from 2018 to 2023. There is significant growth in the number of users, from 107 million in 2018 to 309 million in 2023. This growth appears exponential, indicating increased interest and demand for online courses. The level of implementation of e-learning also increases steadily, from 4% in 2018 to 31% in 2023. It highlights the growing role of e-learning in educational systems. There is a steady rise in the adoption of blended learning from 31% in 2018 to 70% in 2023, confirming the trend towards integrating traditional teaching methods with online components. Mobile learning shows a gradual increase from 43% in 2018 to 61% in 2023, becoming more popular due to the development of mobile technologies. The confident growth of AI in education, from 14% in 2019 to 31% in 2023, emphasises the increasing application of artificial intelligence in educational processes. The usage level of cloud technologies increased from 55% in 2018 to 85% in 2023,

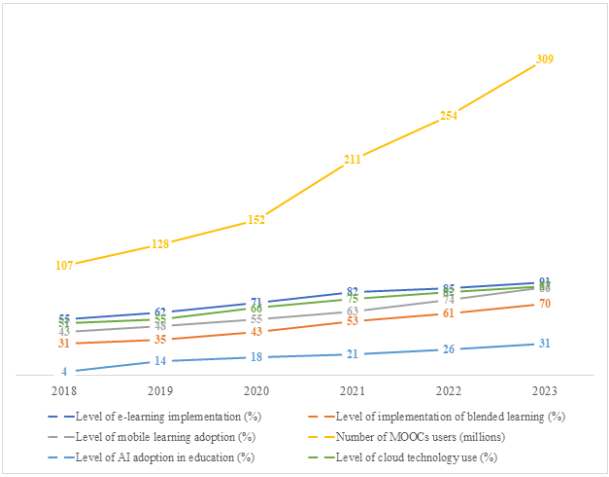

Figure 1: Statistical Data of Modern Technologies Implementation in Higher Education (2018–2023) Created based on: Amenduni & Ligorio [1]; Batsurovska [27]. El-Sofany & El-Haggar [9]; Bilow [7]; Sokhina et al. [11]

making cloud technologies an integral part of educational infrastructure.

The graph demonstrates a positive trend in implementing various modern technologies in education, indicating continuous development and adaptation of educational systems to new technological opportunities. Particularly notable are the growth of MOOC users and the increased usage of cloud technologies and AI in educational processes.

Modern technologies are crucial in transforming the educational process in higher education institutions. Examples of the implementation of such technologies in various leading institutions must be considered.

One significant example is blended learning, which combines traditional teaching methods with online technologies. Universities such as: – Harvard University and the Massachusetts Institute of Technology (MIT) actively implement the edX platform for blended learning courses, which provides flexibility and accessibility to education.

– The University of Toronto actively uses blended learning so that students can combine in-person and distance learning.

Mobile learning opens up new possibilities for accessing educational resources anytime and anywhere:

– Stanford University offers mobile apps and courses for smartphones and tablets, allowing students to study conveniently.

– The National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" actively uses mobile technologies for distance learning, making education more accessible. The use of artificial intelligence (AI) and machine learning for personalised learning is becoming increasingly popular:

– Carnegie Mellon University integrates AI into educational processes to create adaptive learning systems that cater to individual student needs.

Learning technology	Advantages	Disadvantages
Electronic learning (e-learning)	accessibility, flexibility, cost-effectiveness	technical problems, motivation, limited communication
Blended learning	integration of best practices, in-depth understanding	the complexity of the organisation, double workload
Mobile learning (m-learning)	convenience, interactivity	limited capabilities of devices, distractions
Massive open online courses (MOOCs)	wide access, variety	low completeness, less personalisation
Game-based learning (gamification)	increased motivation, improved memorisation	distractions, different interests
Virtual and augmented reality (VR/AR)	realism, interactivity	cost, technical difficulties
Artificial intelligence (AI) and machine learning	personalisation, efficiency	data dependency, ethical issues
Cloud technologies	collaboration, accessibility	security, dependence on the Internet

Table 1: Advantages and Disadvantages of Different Learning Technologies in Higher Education

– The University of Cambridge uses machine learning to analyse educational data and improve the quality of education.

Cloud technologies provide flexibility and accessibility to educational resources: – The University of California, Berkeley, actively uses cloud platforms for storing and sharing educational materials, facilitating collaborative work between students and teachers.

– V. N. Karazin Kharkiv National University uses cloud technologies for distance learning, allowing students and teachers to interact through cloud services.

Massive open online courses (MOOCs) provide access to courses from leading universities [28]. The University of Oxford and Yale University offer courses through platforms like Coursera and edX, allowing students worldwide to receive quality education.

Virtual and augmented reality (VR/AR) technologies are used to create interactive models and simulations:

– Imperial College London uses VR for medical education, allowing students to interact with virtual patients.

– The National University of Life and Environmental Sciences of Ukraine uses VR/AR in engineering education to model natural processes [29].

Examples from leading universities demonstrate the significant impact of modern technologies on improving the quality of education and the professional competencies of students. These technologies create a more flexible, interactive, and accessible educational process. Properly using technologies such as blended learning, mobile technologies, AI, cloud technologies, MOOCs, and VR/AR can increase the effectiveness of the learning process and the level of student knowledge. Table 2 below includes recommendations for implementing and using modern learning technologies.

Modern learning technologies play a crucial role in transforming the educational process in higher education institutions, contributing to its quality and accessibility. Careful planning, educator training, and the integration of technologies into the learning process ensure the effective use of digital tools. For the optimal implementation of new technologies, it is essential to consider both the benefits and potential risks. Regular assessment and adjustment of implementation strategies will help adapt educational processes to the evolving needs of students and educators.

VI. Discussion

Implementing modern technologies in the educational process of higher education institutions is a multifaceted issue requiring a comprehensive approach. Research shows that different technologies have unique advantages and disadvantages, which must be considered during performance.

One of the most discussed technologies is blended learning, which combines traditional teaching methods with online technologies. Research by Amenduni and Ligorio [1] highlights that blended learning enhances the educational process's efficiency due to its flexibility and accessibility. However, Mirajkar [2] emphasises that implementing this technology requires significant resources and organisational changes, which may be an obstacle for some institutions.

Mobile technologies are also becoming increasingly popular in higher education. El-Sofany and El-Haggar [9] argue that mobile learning improves learning outcomes through the interactivity and accessibility of educational materials at any time and place. However, Kustandi et al. [30] point out the technical limitations of mobile devices and potential distractions that could negatively impact students' concentration.

Using artificial intelligence (AI) and machine learning opens new opportunities for personalising the learning process. Bilow [7] emphasises that AI can significantly improve learning efficiency through adaptive systems tailored to students' needs. However, Stepanova [3] warns of possible ethical and legal issues associated with using AI in education, such as data protection and algorithmic fairness.

Cloud technologies provide flexibility and convenience in accessing educational materials, enhancing collaboration between students and instructors. Sokhina et al. [11] note that cloud platforms facilitate teamwork and information sharing, a crucial aspect of modern education. However, Tayirova [12] highlights risks related to data security and dependence on internet connectivity, which may limit the use of these technologies in certain regions.

Thus, the discussion around implementing modern technologies in higher education underscores the need for a comprehensive approach that considers technical, organisational, ethical, and legal aspects. Despite the evident advantages, it is essential to carefully plan and assess the implementation of technologies to minimise potential risks and maximise the positive impact on the educational process.

VII. Conclusion and Prospects for Further Research

Modern learning technologies play a crucial role in transforming the educational process in higher education institutions, contributing to its quality and accessibility. Blended learning demonstrates high efficiency by integrating traditional and on-

No	Recommendation.	Detailed description
1	Assessment of needs and Opportunities	Assess the needs of students and teachers. Assess the university's infrastructure capabilities to support new technologies.
2	Planning and strategy development	Develop a technology implementation strategy with short-term and long-term goals. Create an application roadmap.
3	Training and support for teachers	Organise training and workshops for teachers. Create a support centre to address technical and methodological issues.
4	Pilot projects and feedback	Start with pilot projects to test new technologies. Gather feedback to adjust the application.
5	Integration of technology into the learning process	Integrate technology to complement traditional learning methods. Use blended learning to combine online and offline methods.
6	Personalisation of learning	Implement adaptive AI-based learning systems to personalise the learning process. Create customised learning plans.
7	Development of mobile learning	Provide access to educational resources through mobile apps and platforms. Encourage the use of mobile devices for learning.
8	Use of virtual and augmented reality (VR/AR)	Implement VR/AR technologies to create interactive learning materials and simulations. Use VR/AR for practical training.
9	Gamification of the educational process	Introduce gamification elements to increase student motivation. Use the Kahoot! and Quizlet platforms to create engaging activities.
10	Cloud technologies for collaboration	Use cloud-based platforms to store and share learning materials. Encourage collaboration on projects through cloud services.
11	Performance evaluation and monitoring	Regularly evaluate the effectiveness of implemented technologies based on student performance and teacher feedback. Adjust your strategy based on data.

Table 2: Recommendations for the Optimal Implementation and Use of Modern Learning Technologies

line teaching methods, providing flexibility and convenience for students. Mobile technologies significantly improve the accessibility and interactivity of educational materials, positively affecting students' learning outcomes. Artificial intelligence (AI) and machine learning open new possibilities for personalising the educational process and adapting learning to students' needs. Cloud technologies facilitate collaboration and information exchange between students and instructors, providing access to educational materials anytime and anywhere. Implementing modern learning technologies requires careful assessment and planning to minimise risks and maximise the positive impact on the educational process. Despite the evident advantages, it is necessary to consider technical, organisational, ethical, and legal aspects while enforcing new technologies in the educational process.

Prospects for further research include studying specific mechanisms for integrating modern technologies into the curricula of higher education institutions. Additional research is also needed to assess the long-term impact of these technologies on the quality of education and the professional competencies of graduates.

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