DIGITAL TRANSFORMATION OF HIGHER MEDICAL EDUCATION: CHALLENGES, OPTIMIZATION

TRANSFORMAÇÃO DIGITAL DO ENSINO MÉDICO SUPERIOR: DESAFIOS, OPTIMIZAÇÃO

TRANSFORMACIÓN DIGITAL DE LA ENSEÑANZA MÉDICA SUPERIOR: RETOS, OPTIMIZACIÓN

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ABSTRACT: The purpose of the article is to analyze the digital transformation of higher medical education, trace individual challenges and methods of optimization to improve the pedagogical process. To realize this goal, a number of scientific methods are applied, including analysis, synthesis, deduction and induction, abstraction, and prognostic method. In the results, the aspects of the digitalization processes of the formation of the educational medical environment through the prism of optimization and the challenges on the way to improving the digitalization of higher medical education institutions of Ukraine are investigated. Certain difficulties have been noted on the way to the introduction of innovative technologies, which in Ukrainian realities are mostly related to the lack of technology and funding. In the conclusions, the main attention is paid to the fact that in the future the evolution of digital technologies will pose new challenges for pedagogical thought and its development.

KEYWORDS: Higher medical education. Digital technologies. Ukraine. Innovation. Optimization.

RESUMO: O propósito deste artigo consiste na análise da transformação digital no contexto do ensino superior em medicina, com a identificação de desafios individuais e a apresentação de métodos de otimização destinados a aprimorar o processo pedagógico. Para atingir esse propósito, uma gama de métodos científicos foi empregada, abarcando análises, sínteses, deduções e induções, bem como abstração e aplicação do método prognóstico. Os resultados obtidos se dedicam à investigação dos aspetos inerentes à digitalização do ambiente de ensino médico, com um enfoque na otimização, bem como aos desafios que permeiam o avanço da digitalização nas instituições de ensino superior em medicina na Ucrânia. Notáveis obstáculos foram identificados na implementação de tecnologias inovadoras, particularmente relacionados à falta de recursos tecnológicos e financeiros nas circunstâncias ucranianas. Nas conclusões, enfatiza-se a importância de se reconhecer que, no futuro, a evolução das tecnologias digitais trará novos desafios para o pensamento pedagógico e seu desenvolvimento.

PALAVRAS-CHAVE: Ensino superior em medicina. Tecnologias digitais. Ucrânia. Inovação. Otimização.

RESUMEN: El propósito de este artículo consiste en analizar la transformación digital en el contexto de la educación superior en medicina, identificando desafíos individuales y presentando métodos de optimización destinados a mejorar el proceso pedagógico. Para lograr este propósito, se empleó una variedad de métodos científicos, que incluyeron análisis, síntesis, deducción e inducción, así como la abstracción y la aplicación del método pronóstico. Los resultados obtenidos se centran en la investigación de los aspectos inherentes a la digitalización del entorno de la educación médica, con un enfoque en la optimización, así como en los desafíos que rodean el avance de la digitalización en las instituciones de educación superior en medicina en Ucrania. Se identificaron obstáculos significativos en la implementación de tecnologías innovadoras, especialmente relacionados con la falta de recursos tecnológicos y financieros en las circunstancias ucranianas. En las conclusiones, se enfatiza la importancia de reconocer que, en el futuro, la evolución de las tecnologías digitales planteará nuevos desafíos para el pensamiento pedagógico y su desarrollo.

PALABRAS CLAVE: Enseñanza superior en medicina. Tecnologías digitales. Ucrania. Innovación. Optimización.

Introduction

As demonstrated by the quarantine restrictions in response to the COVID-19 pandemic, the latest digital opportunities are not inferior to traditional education and are widely available for independent use, not limited to a mere complement to in-person classes. However, the situation differs considerably in higher medical education, where theoretical learning is intrinsically linked to acquiring practical skills and relevant competencies. This presents specific challenges for the implementation of distance learning, as well as the use of multimedia technologies and innovative methods, as the effectiveness of these approaches will need to be tested and adjusted over time, temporarily aligning with established teaching standards.

Furthermore, there are other challenges associated with adopting new forms of digital learning in medicine, which have been partially addressed in the scientific literature. Therefore, this article aims to investigate the critical aspects of digital transformation in higher medical education, identifying specific challenges and optimization strategies to enhance the educational process.

Literature Review

The issue of training medical educators based on modern, innovative digital technologies has been the subject of active research by contemporary scholars. In this context, several authors explore the prospects of medical education based on the analysis of modern innovative technologies. It is relevant to highlight that social media and other digital resources have considerably expanded the tools available for medical student learning (COLLIER, 2014).

Jacob (2020) on the other hand, investigated models and fundamental areas for enhancing the medical industry, especially in light of the significant changes triggered by the recent pandemic. Essential aspects of the future development of medical education through digital transformation were addressed by Das *et al.* (2022), who argue that contemporary medical educators must be able to critically assess both the significant benefits and limitations of the digital environment.

Consequently, the primary responsibility of a digital educator lies in the balanced integration of digital and conventional teaching methods to empower modern students to acquire new knowledge and use it competently (DAS *et al.,* 2022). Rani, Kaur and Sharma (2022) outline the key challenges and threats associated with distance learning through a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats). Pears and Konstantinidis (2021)

investigated the specific characteristics of applying immersive technologies in the training of medical students. Meanwhile, Chen and Banerjee (2021) characterized the main aspects of digitization in higher medical education. Desai and Karous (2023) emphasized the importance of digital competence for future medical professionals.

In the same context, the work of Nourzaie, Mohammed and Batt (2018) titled "*Digital Education: The Future of Medical Education?*" outlined the key opportunities and directions for developing digital medical education while identifying some limitations in its widespread adoption.

Jena, Gupta and Mishra (2021), explored the issue of the effectiveness of digital education, comparing it with traditional teaching models. Radziievska *et al.* (2022) conducted an in-depth analysis of the key aspects involved in transforming higher medical education. Raza and Hussain (2022) provided a comprehensive overview of the problems and challenges faced by contemporary higher medical education.

Yuriy *et al.* (2022) detailed the main opportunities for using digital technologies and simulation to train future healthcare professionals. Herrera-Aliaga and Estrada (2022) identified modern trends and innovations in the development of higher medical education, while Han, Sung, and Shin (2022) characterized the essential aspects of using virtual simulation technologies in training future doctors. The study by Bader, Oleksiienko, and Mereniuk (2022) offered an analysis of the critical risks associated with implementing digitization in education and strategies to mitigate them. The topic of modernizing the educational sector through immersive technologies was addressed by Bakhmat *et al.* (2022).

Methodology

This article employs general theoretical (logical) and specific pedagogical research methods. Among the available theoretical methods used, the following stand out: analysis, synthesis, induction, and deduction, which are characteristic of academic research (BADER; OLEKSIIENKO; MERENIUK, 2022). Analysis was used to break down the object of study into components, encompassing a review of the scientific understanding of the problem and the characterization of the main transformations in higher medical education in Ukraine resulting from the introduction of modern and innovative teaching methods. Synthesis was applied to integrate the selected parts. Raza and Hussain (2022) indicate that this approach is appropriate for theoretical exploration. Prospective research allowed for anticipating the main directions of the future development of medical education in Ukraine, while axiological research involved identifying the fundamental guiding values and principles that will steer the continuous evolution of higher medical education institutions.

Results

The digitalization of the educational space in higher medical education institutions: An optimization perspective

Current trends in the labor market's development are intrinsically linked to the ability of future medical professionals to acquire, interpret, and apply information in the digital context. As a technological process, digitalization provides students with a range of tools to address individual tasks and complex problems. As a result, future medical professionals who utilize various digital technologies, whether for communication or information retrieval, become more adept at solving a wide variety of complex issues, many related to the preservation of physical and mental health. These advancements lead to an increased demand in the job market, along with the formation of new digital requirements for healthcare professionals. In the context of the digital society, concepts such as lifelong learning, STEM education, and lifelong development gain particular relevance, as modern universities must equip their students with all the fundamental competencies of a contemporary digital citizen (NOURZAIE; MOHAMMED; BATT, 2018).

Thus, contemporary educational trends are being shaped by the bias of technologies, contributing to enhancing the electronic educational environment. One evident aspect of the digital transformation of education is the adoption of remote technologies, which significantly impact the overall quality of education. These technologies undoubtedly open up new

educational perspectives, transcending the barriers of time and space in the teaching-learning process (RADZIIEVSKA *et al.,* 2022). It is essential to mention that the pronounced deterioration of conditions due to the COVID-19 pandemic and the subsequent large-scale invasion of Ukraine by the Russian Federation in 2020-2021 represented a strong impetus for the rapid development of technology adoption. Medical universities in Ukraine faced the challenge of swiftly transitioning from traditional working models to the widespread adoption of distance learning technologies (RADZIIEVSKA *et al.,* 2022). This shift allowed for minimizing in-person contacts, thereby contributing to the safety of all involved in the educational process.

Current advancements in digitalization also play a crucial role in the development of optimized strategies in the field of medical education. A notable example is the emergence of innovative programs designed to empower the next generation of healthcare professionals, preparing them for a digital landscape. The CardioNerds Academy, for instance, has conceived a program that focuses on teaching fundamental research skills and creating digital educational content for medical students. Furthermore, medical residents can acquire skills for effectively utilizing the tools offered by the digital environment to benefit their professional careers. These training programs are available in specialized research institutions (DAS *et al.,* 2022). Given that this domain is in constant evolution, a range of prospective opportunities arise to investigate the optimization of digital medical education curricula and how digital technologies can be further developed to meet the needs of both educators and students. An example is the United Kingdom, where a specialized postgraduate module called "Essential Knowledge for Obstetrics" was developed in collaboration with King's College London. This program is delivered in a hybrid format, significantly focusing on using virtual technologies (JACOB, 2020).

Chen and Banerjee (2021) highlighted the contribution of virtual technologies to the optimization of teaching crucial disciplines, particularly in diagnosing and treating pregnancy-related medical conditions. Implementing digital technologies in the context of education, including modalities such as E-learning, M-learning, and U-learning, has comprehensive impacts on the overall quality of the educational process and the enhancement of communication between teachers and students. The digitization of the academic environment in higher education institutions has the potential to increase knowledge acquisition efficiency by up to 20–30% (YURIY *et al.,* 2022). As innovative digital technologies are integrated into higher medical education, there is a transformation in the tools, means, methods, and traditional

teaching technologies. Furthermore, the optimization possibilities provided by digital technologies are extensive. Implementing M-learning tools, for example, has proven to be cost-effective, reducing the need for facility rental and maintenance expenses, administrative bureaucracy, and operational costs (RANI *et al.,* 2022). The E-learning system enables the efficient delivery of lectures and webinars to a large audience, incorporating visual materials from various sources to enhance presentation.

Challenges in the digitalization of Higher Medical Education

Training future doctors traditionally focuses on building practical skills through hands-on education. However, the transition to a digital learning system requires adequate infrastructure, including the availability of computers and internet access in clinical settings. The lack of IT specialists in educational institutions also poses a substantial barrier (DEVADZE; GECHBAIA; GVARISHVILI, 2022). In this context, the creation of specialized departments dedicated to implementing IT technologies in higher medical education is suggested (BADER; OLEKSIENKO; MERENIUK, 2022).

In addition to these challenges, the digitalization of medical education also faces other significant issues. The scarcity of access to technology is a highly relevant problem, as highlighted by numerous contemporary scholars worldwide, characterizing it as a global challenge. Another critical challenge involves the need for proficient use of digital technologies. Bakhmat *et al.* (2022) emphasize the importance of implementing specific training programs for teachers and students to develop their digital literacy and digital communication culture.

Another significant issue is the adaptation of teaching approaches. Teaching theoretical subjects in the context of universities demands adopting new active methods that promote interaction and collaboration between students and teachers (MALLAM; NAZIR; RENGANAYAGALU, 2019). Therefore, the primary focus should be promoting students' critical thinking, encouraging the search for creative solutions to atypical problems, and developing communication skills and digital competence.

According to the latest Davos Economic Forum, preparation for the digital era is not limited to competence in managing digital technologies but also encompasses the ability to enhance and actively apply them in professional activities, focusing on preserving human lives.

This process assumes special relevance in the context of training future medical professionals. However, the effective implementation of electronic (E-learning) and mobile (M-learning) teaching based on digital technologies faces significant data storage and protection challenges. Not all learning platforms ensure an adequate level of personal data security.

Recent comparative studies involving Zoom, Microsoft Teams, and Google Meet platforms have identified Zoom as the least secure option. This underscores the importance of addressing the phenomenon known as "Zoom bombing," which involves the intrusion of unauthorized individuals into broadcasts (RAZA; HUSSAIN, 2022). While other platforms may offer relatively better security levels, there is still room for significant improvements. At the same time, we face the challenge of inadequate funding availability for developing digital medical education, as seen in Table 1.

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Table 1 - Challenges of Digitization in the Medical School

Challenge	Explanation
The teaching of practical disciplines relies on the use of contemporary technologies	Incorporating simulation and digital technologies is crucial for higher education in medicine. However, these technologies involve substantial expenses, not only in the initial acquisition but also in the ongoing maintenance and updates of the required software and equipment.
Availability of infrastructure and connectivity at clinical sites	Unfortunately, many hospitals and practice institutions still do not have established access to the World Wide Web, hindering online education's effective implementation.
Development of IT capabilities	The establishment of specialized Information Technology (IT) departments and the presence of these experts in medical education institutions.
Budgetary constraints	The implementation of digital medical education is costly, encompassing substantial expenses for acquiring digital and simulation equipment and procuring related software and resources.
Limited access to technology	The lack of access to suitable devices and software presents a significant challenge, hindering some institutions from effectively implementing E-learning and M-learning.
Potential technical issues	The widespread use of technology in the educational environment can give rise to technical problems, including software failures and internet connectivity issues.
Data security issues	Current research reveals a significant risk of identity theft on educational platforms. Therefore, ensuring the protection of students' data is crucial, although it can be challenging in an era of widespread digitization in higher medical education.
Lack of digital competence	The lack of familiarity and competence with digital technologies is a hurdle affecting students and teachers. Inexperience in this domain can negatively impact the organization and effectiveness of digital education.
Training for efficient technology use	Even though medical universities have access to all essential digital technologies, not all professors may be able to utilize them effectively.
Adaptation in teaching approaches	The ongoing development of digital medical education requires modifications in approaches, technologies, methods, and forms of instruction.

Need for a cultural and mental transformation	Digital medical education implies a shift in cultural and mental attitudes, which can be challenging for all involved in the educational process.
The role of the teacher	Teachers must take on the part of mentors and role models, supporting the educational development of students and guiding them on the appropriate path, an approach that contrasts with the teacher's traditional role of knowledge transmission.

Source: Elaborated by the authors

Thus, we encounter inherent obstacles in the digitalization of higher medical education, whose prospective resolution will promote the optimization of electronic learning (E-learning) and mobile learning (M-learning) processes in the context of medical education.

Discussion

As previously addressed in studies, the shortage of telecommunications infrastructure and essential software products became more evident during the pandemic (CHEN; BANERJEE, 2021; DHAWAN, 2020). However, our perspective suggests that these issues have taken on secondary importance. Due to the challenges posed by globalization, the educational landscape has undergone significant transformation, leading to the widespread adoption of digital technologies in the training of future professionals, a phenomenon that has become common in contemporary education.

Nevertheless, according to recent studies (PEARS; KONSTANTINIDIS, 2021; SHAVEL *et al.,* 2021), there is still a lack of awareness among educators themselves regarding the widespread use of digital practices. Sometimes, in the context of online teaching, teachers apply traditional teaching methods to the electronic format (HAN; SUNG; SHIN, 2022). For instance, there is a mechanical transfer of textbooks, assignments, and other materials to the electronic format, making the organizational process more complex: the workload of students increases, and the quality of knowledge decreases.

Simultaneously, the predominantly monological structure of the educational system amplifies its informative aspect, resulting in an overload of educational content, loss of motivational stimulus, and ineffective organization of digital communication. As discussed by Das *et al.* (2022), contemporary digital technologies have the potential to refocus medical education, making it more student-centered and accessible. However, it is imperative to

recognize that the digital era is not exempt from substantial challenges.

In addition to the issues mentioned in the results of this study, Das *et al.* (2022) highlight the additional concern arising from the use of digital resources in medical education: the propensity for misinformation. Traditional educational content is regarded as reliable; however, the open nature of digital resources implies limitations in ensuring their quality. Therefore, users of digital information must exercise caution when using and interpreting it.

To address this issue, Das *et al.* (2022) suggest that students engaging in the digital environment should actively seek, evaluate, and discern potential sources of misinformation. It is paramount to emphasize that the adverse health implications resulting from disseminating incorrect medical information represent an urgency in preparing future healthcare professionals to use social networks to debunk misconceptions and false information skillfully.

To address the challenges outlined earlier in the context of digitization in higher medical education, we propose the following measures:

- Development of professional training for future doctors through the integration of web-enhanced learning;

- Establishment of websites and platforms within the network of medical and educational institutions aimed at analyzing educational information and data related to the practical work of healthcare professionals (HERRERA-ALIAGA; ESTRADA, 2022);

- Promotion of using virtual programs and simulations in the digital teaching environment. This will enhance students' theoretical knowledge and provide a detailed demonstration of practical solutions in specific situations. The widespread introduction of digital programs and simulations in the training of future doctors is also emphasized by other researchers (YURIY *et al*., 2022; RADZIIEVSKA *et al*., 2022; HERRERA- ALIAGA; ESTRADA, 2022);

- Establishment of electronic medical libraries based on the websites of higher education institutions (YURIY *et al.,* 2022);

- Utilization of mobile learning technologies (COLLIER, 2014);

- Creating readily accessible medical educational apps designed to enhance the practical skills of future doctors. Additionally, various mobile programs are planned to enable students to explore topics not part of the conventional curriculum;

- Adoption of various virtual reality platforms (YURIY *et al*., 2022; CHEN & BANERJEE, 2021). In this context, a crucial step is the integration of virtual patients into the

professional training system aimed at optimizing education;

- Employing new approaches and methods in organizing educational activities (MYRONENKO *et al.,* 2022);

- Expanding the use of information and communication technologies. According to Yuriy *et al.* (2022), it is imperative that teachers provide exemplary videos of medical procedures and consultations, which should be posted on online learning portals;

- Enhancing digital competence for students and teachers (DESAI; KAROUS, 2023). This can be effectively achieved through the organization of specialized conferences and webinars. Bader, Oleksienko and Mereniuk (2022), emphasized that digital competence represents one of the most crucial skills for a contemporary educator. Simultaneously, educators can enhance their skills by participating in specific in-service training courses or engaging in internships;

- Development of information literacy, which encompasses the ability to use modern means of communication and other information resources effectively and can be promoted through participation in supplementary courses;

- Implementation of an accessible grant system to support critical medical education institutions and their involvement in international projects, as well as technological and scientific cooperation programs, is an important measure to consider.

These guidelines are recommendations that can be adjusted in accordance with the evolution of digital technologies and circumstantial conditions.

Final consideration

Therefore, digitizing the educational process in medical colleges is a relevant contemporary phenomenon that faces significant challenges in its implementation. Future physicians' use of digital technologies, communication, and information is essential for effectively resolving complex issues related to physical and mental health, resulting in a growing demand for qualified healthcare professionals.

On the other hand, the modernization of distance medical education presents several challenges, including teaching practical disciplines, the lack of adequate technical infrastructure, planning issues, financial constraints, equipment maintenance and repair, digital security concerns, and the need to develop appropriate digital competencies. Furthermore, it

requires a cultural and mental transformation among teachers and changes in the methodology of organizing the educational process.

In this study, solutions are proposed to optimize higher education in medicine, including the development and enhancement of digital and information competencies for both teachers and students, the promotion of web-based learning, the creation of robust and secure internet platforms, the widespread adoption of simulation technologies, virtual reality, and mobile learning in the training of future experts, as well as the integration of traditional knowledge with digital and interactive approaches. Additionally, the exploration of new methods and practices and the encouragement of the grant system are suggested.

It is essential to highlight that overcoming the challenges mentioned above in the future will require further research, as the continuous advancement of digital technologies will bring new challenges to it. The solutions presented are initial guidelines and will require constant refinement as technology evolves.

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