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Analysis of the effectiveness of the implementation of digital technologies in the educational process of medical HEIs: challenges, optimization

Análisis de la eficacia de la implementación de las tecnologías digitales en el proceso educativo de las IES de medicina: retos, optimización

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Abstract

The COVID-19 pandemic has led to the more intensive use of digital technologies in higher medical

education. The purpose of the study was to analyze the effectiveness of the implementation of digital technologies in the educational process of Ukrainian medical universities, to identify the current challenges e-learning faces, and to propose potential ways of optimization. General scientific methods (for example analysis, synthesis) specific pedagogical methods (specification, abstraction, comparison forecasting) were used for the research. The results outline the main advantages of using digital technologies in the medical higher school system. Attention is also drawn to the main challenges that have a certain negative impact on the educational process. Among the latter, problems with the practical training of future doctors were noted since distance learning does not provide an opportunity to fully implement skills building component. The results also highlight possible ways to solve the problems of using digital technologies in medical higher education institutions. It is proposed to introduce to use not only distance learning technologies, but to combine them with the traditional approach and independent learning. It is emphasized about further studies, as empirical measurements of the effectiveness of distance education in the medical field. And, this effectiveness still needs to be ultimately proven.

Keywords: higher medical education, digitalization, challenges, prospects.

Resumen

A pandemia de COVID-19 levou ao uso mais intensivo de tecnologias digitais no ensino superior médico. O objetivo do estudo foi analisar a eficácia da implementação de tecnologias digitais no processo educacional das universidades médicas ucranianas, identificar os desafios atuais que o e-learning enfrenta e propor possíveis formas de otimização. Métodos científicos gerais (por exemplo, análise, síntese) métodos pedagógicos específicos (especificação, abstração, previsão de comparação) foram usados para a pesquisa. Os resultados destacam as principais vantagens do uso de tecnologias digitais no sistema de ensino superior médico. Chama-se ainda a atenção para os principais desafios que têm um certo impacto negativo no processo educativo. Entre estes últimos, foram notados problemas com a formação prática dos futuros médicos, uma vez que o ensino à distância não oferece a oportunidade de implementar plenamente a componente de desenvolvimento de competências. Os resultados também destacam possíveis caminhos para resolver os problemas do uso de tecnologias digitais em instituições médicas de ensino superior. Propõe-se introduzir o uso não apenas de tecnologias de ensino a distância, mas combiná-las com a abordagem tradicional e o aprendizado independente. Ressalta-se a continuidade de estudos, como medidas empíricas da eficácia da educação a distância na área médica. Ainda precisa ser finalmente provado.

Palabras clave: enseñanza médica superior, digitalización, retos, perspectivas.

1. Introduction

The modern development of information technology has a tangible impact on global social processes, dictating new conditions for the functioning of many institutions. Higher medical education is of no exception to the rule and is also being transformed in accordance with the requirements of modern information systems capabilities. The COVID-19 pandemic has had negative manifestations, but it has also stimulated some positive trends. In particular, distance education with its quality and capabilities, has for a long time been evaluated exclusively as secondary to traditional, full-time tuition. Quarantine restrictions have shown that these assessments are biased, and the benefits of distance education are also quite real.

Universities have introduced a distance form of education, which differed from the traditional model of education. This led to the emergence of certain issues, which are still little evaluated by researchers and require additional reflection in terms of practicality and the prospects for further use of the proposed methods of training. In view of the fact that medical training requires certain higher improvement of training (since it refers to an important and sensitive area of public life), the negative aspects of distance learning in this field are more pronounced and, consequently, more destructive.

The aim of the study is to analyze the effectiveness of the implementation of digital technologies in the educational process of medical institutions of higher education, identifying the current challenges facing it and suggesting potential ways of optimization. The article considers the hypothesis of the general advantages of distance learning, but it is noted that the work in the field of medical universities will require the implementation and compliance with certain conditions to comply with the effectiveness.

2. Literature Review

The literature base of the study consists of scientific works of American, Ukrainian and European educators. A team of Ukrainian scientists Safonov et al., (2022) believe that total digitalization has both advantages and disadvantages. They note that the Organization for Economic Cooperation and Development of the European Union pays special attention to the digitalization of education, while in Ukraine the development of digital skills of the population is one of the key priorities of the government in the system of digital transformation and plays a special role in ensuring social progress.

Jena et al., (2021) through the lens of analysis compared the traditional model of e-learning, and identified the key advantages and opportunities of distance learning. Jacob (2020), in an article entitled *The New Face of Medicine* characterized key contemporary transformations in medicine, with notable attention paid by the author to the particularities of using digital and simulation technologies in modern medicine. Raney et al., (2022) noted that as a result of the Covid - 19 pandemic, the use of e-learning has become a new and widespread principle in the implementation of educational services around the world. However, many developing countries are largely agrarian and cannot provide the necessary infrastructure for digital education.

Consequently, the aforementioned authors analyzed the key challenges and opportunities faced in providing educational services online, taking into account the views of students and teachers. Meanwhile, Salvati (2019) in a paper titled "Medical Education in the Digital Era" described the key digital transformations in medical education. Chen & Banerjee (2021) also described the main features of the use of digital platforms in medical education, in particular, the authors believe that the use of social platforms such as Twitter and Facebook to spread the latest medical advances has become the norm. In addition, according to Chen & Banerjee (2021), most educational regional societies held educational webinars that were accessible to anyone if they had Internet access. Sorg et al., (2022) described key aspects of the digitalization of the educational medical space based on the German experience with distance learning. Bader & Mereniuk (2022) identified the importance of digital literacy against the backdrop of military aggression. The authors noted the relevance of digital and information competence against the background of global changes. The main models, implementation mechanisms of digital learning were analyzed by Laufer et al., (2021). At the same time, Jenkins et al., (2021) described key innovative aspects of the "rebirth" of individual medical disciplines.

The Tsekhmister et al., (2021) team characterized the challenge of implementing virtual digital technologies in the training of medical aspirants. Succar et al., (2021) identified the impact of global

challenges (as well as the Covid-19 pandemic) on the transformation of ophthalmology student education. Ottinger et al., (2021) investigated the specifics of using virtual platforms in undergraduate medical education.

3. Materials

The materials of the study were European and Ukrainian legislative acts, system of distance learning, which includes web-based platforms, applications, personnel necessary to support e-learning, students' readiness to succeed with distance learning, and results of standardized tests.

The following Ukrainian legislative acts were investigated: "Concept of digital transformation of education and science of Ukraine" and "Strategy for the Development of Higher Education of Ukraine for 2021-2031". Of high importance was the use of the European Commission strategy on the digitalization and innovative development of Europe: "A New Industrial Strategy for Europe" (European Commission, 2020).

A number of web-based platforms and applications (Zoom, GoogleMeet, etc.) were used to implement educational curricula against results of standardized test. Among soft skills necessary for students to successfully participate in distance learning motivation, technical readiness, and some other were studied.

Overall number of the students engaged into study was 120 persons. Research work with them was organized on the basis of anonymity and voluntariness.

4. Methodology

The research uses theoretical general scientific methods. In particular, based on the analysis, the main subject of the study (digital technologies in medical education) is characterized through the prism of analysis of such problems as the features of digital technology use in the world, coverage of the key advantages and disadvantages of using digital platforms in the medical sphere. As a result of the use of synthesis, these problems are combined and formed their own conclusions and recommendations. Using the systematic method, the process of digitalization of training is considered as being in constant motion and transformation, so it requires analysis with the characterization of possible further results of this process.

With advantage of axiological approach the transition from general theoretical statements to the formation of research conclusions regarding the use of digital technologies in the field of medical education was carried out.

As a result of the predictive method of research we have shown further prospects for the use of digital technologies in medical education. Noteworthy was the use of systematic method of research, based on which a analysis of the advantages and disadvantages, opportunities, and threats of digital technologies in the field of education was implemented.

This theoretical study was implemented in several stages. On the first – researchers determined the relevance of the problem, carried out a content analysis of modern pedagogical literature, on the second –they characterized the features of the use of digital technology in modern education, clarified the advantages and disadvantages in the system of implementation of total digitalization, and at the

third - defined the difficulties in the process of carrying into effect of distance education in medical HEIs. At the last phase of research, the results were processed; conclusions and subsequent recommendations for the use of digital technologies in the system of training of future doctors were formed.

5. Results

Digital technologies in the training of future medical specialists (theoretical review)

The Organization for Economic Cooperation and Development of the European Union pays considerable attention to the digitalization of education, which is changing through the adoption of policy documents, strategies, etc. According to the European Union Coalition, the key focus of modern digitalization is the development and implementation of national digital skills strategies and the formation of national coalitions (European Commission, 2020). At the same time, in the process of developing the e-Health platform, the digital competencies of not only doctors, technical care specialists, but also the entire population of the country are increasing, and therefore the level of digital literacy of the entire society is also increasing (Jenkins et al., 2021). Therefore, an important trend of the modern educational space is the use of digital technologies and the formation of information, digital competence of both applicants for higher education and teachers (Ministry of Education and Science of Ukraine, 2022). Active digitalization of the educational space, the increase in digital learning platforms and resources contributes to the emergence of changes in many educational fields, including medical. The current trends of informatization and digitalization of society influence that labor market trends are related to the skills of applicants for medical professions, to interpret and apply the information correctly (Salvati, 2019). For this reason, the digital competence of health professions teachers is important. At the same time, total informatization as a technological advancement allows teachers to use different digital ways to implement certain learning tasks.

Students often use digital technologies in their daily lives, and they influence the development of narrow skills related to specific platforms and technologies, such as social media and cell phones (Tsekhmister et al., 2021). The development of professional competence is a manageable process of becoming a professional in the medical field, and it is done mainly through education and self-education, acquiring of information and communication competence. Consequently, the proper use of innovative, digital, communication, and information technologies will contribute to the realization of many significant educational and social problems, which in general also relate to the sphere of preservation of human physical or mental health. According to contemporary scholars, innovative digital technology has an impact of 20-30% on improving classroom performance (Rani, Kaur & Sharma, 2022). Also, the introduction of innovative "e-learning" methods affects the reduction of costs for the organization of training (Sorg, Ehlers & Sorg, 2022). In addition researchers have great optimization potential, because facilitate training sessions for a large number of individuals, individual time planning, development of students' personal skills, etc. (See Figure 1).

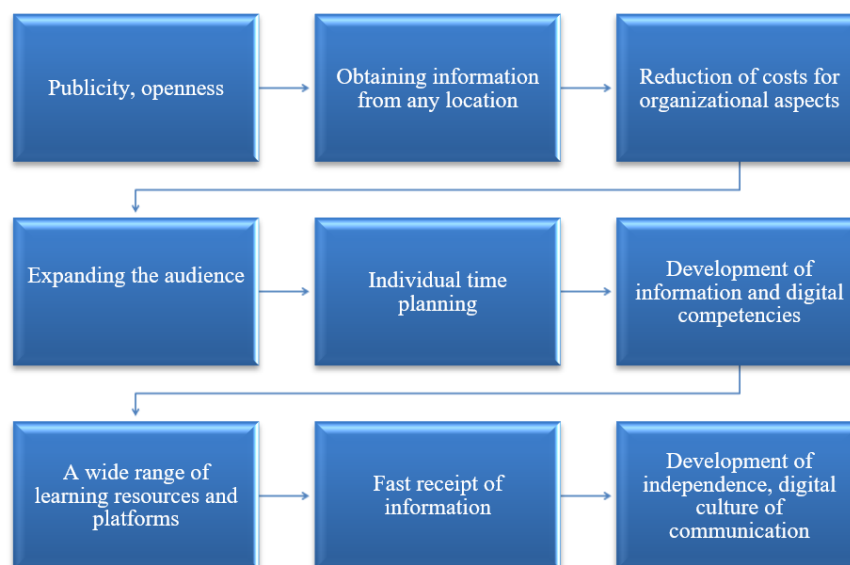


Figure 1. Key advantages of using digital technologies in the educational process
Authors' development

So, the creation of digital skills strategies with formation of national coalitions, implementation of innovative "e-learning", measures of increasing personal digital competence, and creation of digital e-learning platforms are future trends in distance learning development in European Union. Its effective use has been proven on the basis of standardized tests. The results of solving the tasks showed that the level of knowledge of medical students did not decrease.

Steps of distance learning system implementation

The first step in the distant learning system implementation involved the creation of powerful web portals, platforms, and medical HIE resources in a holistic network of treatment facilities, medical institutions (local or global scale) (Motte-Signoret et al., 2021). They should serve as a means of processing, interpreting a large volume of training information and materials for the practical work of physicians (Jarva et al., 2022). The second step involves the formation of professional supervisor system for future doctors through the prism of web-supplemented learning. This aspect will transform traditional learning in medical schools and will develop directly digital learning. The third step implies research and study of individual medical disciplines online using special virtual simulation programs. The mentioned step will influence the formation of future doctors both on theoretical and practical planes.

It is noted that simulation technologies are obligatory in the education and training of specialists in emergency and urgent medical services - based on practical training. The key vectors of simulation training should be:

- A. aspects of cardiopulmonary resuscitation
- B. formation of emergency medical care skills,
- C. gaining skills of medical manipulation, sterilization work, etc in accordance with the specialty: simulation rendering, surgical, gynecological, therapeutic, and other care.

For example, medical manipulation with the help of simulation technology contributes to the practical training of practical skills of injections.

Gynecological simulators are based on models of the development of various gynecological examinations. In this system, computerized simulators that influence the development of practical skills for examining the cardiovascular and respiratory systems stand out. Surgical simulators are formed from digital virtual operating rooms, where the study of the operating and preoperative rooms is performed. On the other hand, virtual technologies play a prominent role in this training system to help organize the control of theoretical and practical training (Succar, Beaver & Lee, 2021).

We also suggest the development of professional medical training applications that would serve to support core training, promote a thorough mastery of practical skills for medical aspirants. A certain step should involve students using a variety of mobile apps that would be publicly available (Bakhmat et al., 2022). Such applications should function on special educational platforms of HEAs and facilitate mass distance learning courses. In the process of professional training of students, an important aspect is the use of video content of medical operations and consultations. They should be placed in a convenient electronic format on accessible resources. A separate aspect is also the development and use of special training platforms of virtual reality, technologies with virtual patients, augmented reality technologies.

In addition, the issue of forming electronic libraries with up-to-date medical information is becoming relevant. They should be placed on the portals of educational institutions.

To achieve positive results in practical training, medical universities switched to a blended learning system. This practice entails separation of the practical and theoretical classes. Theoretical knowledge was planned to be imparted remotely - using Web-based Platforms Zoom, GoogleMeet, and many other similar platforms. Distance learning platforms allowing asynchronous learning mode became important in medical education. And practical skills are proposed to form in direct work in classrooms, on stimulators, in laboratories (for medical biology, etc.), etc. Contacts with patients - work with real clinical situations - also took place. It is important for future doctors to form practical skills, work with real patients, practice manual techniques, but not all remote digital technologies can fully contribute to the implementation of the practical aspect (Jacob, 2020). Therefore, different situational tasks and algorithms of practical skills implementation should be addressed in teaching to bring students as close to practice as possible (Ottinger et al., 2021). We suggest that teachers form multimedia presentations consisting of situational tasks, with 3-4 questions at the end of each task. Each task is displayed on the screen for each student. Thus, students will be able to perform different situational tasks, which will improve their practical work skills.

Some medical universities have suggested using the "single day" methodology, where one day of training is traditionally spent - it is on this day that all practical sessions take place (Radziievska et al., 2022). Medical students have the opportunity to communicate directly with their professors, ask them questions, build hands-on skills, and review interesting topics-all of which are difficult to accomplish in distance learning mode. The rest of the days are spent in distant learning. This kind of educational form allows for more effective use of digitalization because it combines digital studios with hands-on work. In the field of medical higher education, this combination looks like a promising area of educational work that requires further optimization and adaptation for use in e-learning.

6. Discussion

Distance Learning Challenges in Medical HEIs

The current criteria for the educational process are gradually distancing themselves from the changing algorithms for acquiring knowledge that were actively practiced previously (Safonov, Usyk & Bazhenkov, 2022). Due to the development of information technology, modern applicants for higher medical education are independently processing more materials from the Internet, participate in webinars, online conferences, etc.

Such conclusions required detailed systematization, analysis and logical construction. So, it reveals the need for future doctors to form independent algorithms of self-education, which requires students to form a special motivation for learning, obtaining new knowledge, mastering practical work skills, etc. Formation of soft skills is quite a complex and consistent process that needs permanent self-control, systematic updating of their own knowledge, the ability to make generalizations and think globally.

At the same time, one must agree with researchers that the problem of developing of soft skills in educational process is generally inherent in distance education (Jena et al., 2021). However, it is not as relevant for applicants to higher medical education because the vast majority of students have consciously chosen the medical profession and are willing to actively learn (Chen & Banerjee, 2021). On the other hand, medical professions are in demand in society: as the COVID-19 pandemic demonstrated, the social roles and professional status of members of the medical and health professions are extremely high.

Medical students' own research work should be provided with the necessary number of educational materials of methodological and reference character, special and relevant scientific literature. In addition, these materials should be available on the Web, since the medical industry is developing quite dynamically, not all publications need a "paper" format - some of them can also be used in digital form (Bader & Mereniuk, 2022). The current capabilities of universities allow this process to be arranged (Ali, 2022). For example, at the Bogomolets National Medical University, it is possible to access many of the leading scientific publications online, which makes it much easier for medical students to work independently.

First and foremost, distance education requires a tangible, skilled investment of time to shape, develop, and write curricula and syllabi that will provide an enhanced quality of education (Laufer et al., 2021). A particularly important element for medical distance education is the ability to transfer and control clinical experiences (Mishra et al., 2020). Consequently, with a distance learning model, it is difficult to guarantee the development of clinical skills without traditional communication between instructors and students. These observations support the idea of the necessity to look for such important qualities as the interactivity of distance learning, which would simulate live classes and make educational experiences rememberable. These can be attained by: 1) change of task, 2) periodic work in small groups, 3) technologically friendly user interface, etc.

At the same time, the use of educational digital technology in medical education in Ukraine has several important limitations: 1. Predominantly the implementation of training of future physicians occurs in the practical plane; 2. Inadequate provision of Internet and computer capabilities and clinical

databases; 3. The lack or insufficient number of specialists in digital technology and a special department of IT technology maintenance in medical institutions of higher education.

For more effective education with using digital technologies we propose to implement some solutions (See Figure 2).

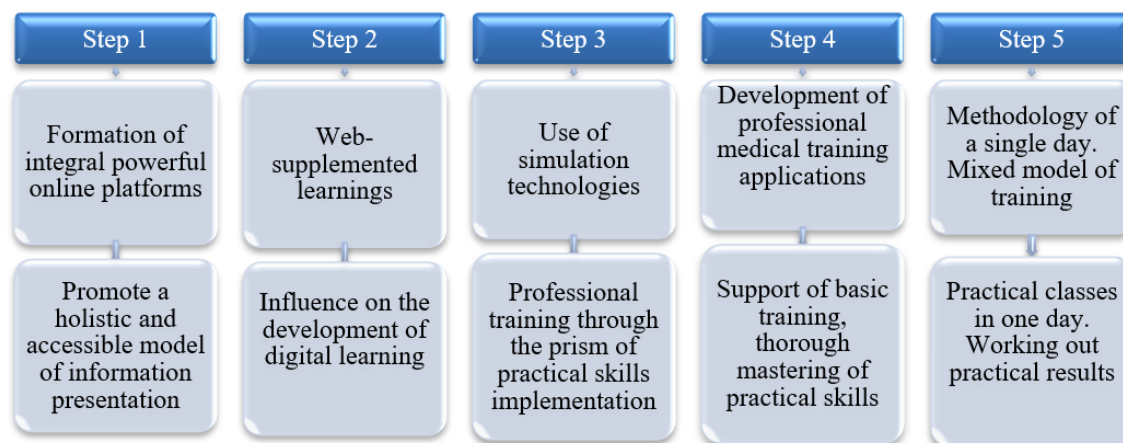


Figure 2. The system of overcoming the limitations of e-learning in medical HEIs

7. Conclusions

As a result of the study, the limitations and challenges of e-learning were defined, as well as the use of digital technologies in the educational process of medical institutions was proven to be effective. Its effectiveness has been proven on the basis of standardized tests. The results of solving the tasks demonstrated that the level of knowledge of medical students did not decrease.

Among the main challenges, we note development of students' soft skills in distance learning process (for example, the need to find self-management to learn) and technical readiness (lack of practical training when using distance learning). If future medical workers do not have many problems with motivation (though the prestige of the medical profession after the COVID-19 pandemic is at a high level), the second challenge requires a more detailed response.

The most significant limitations to overcome were: 1) necessity to train future physicians in the practical plane, 2) In adequate provision of Internet and computer capabilities and clinical databases, 3) The lack or insufficient number of specialists in digital technology and a special department of IT technology maintenance in medical institutions of higher education.

The use of digital technologies in the educational process of medical institutions of higher education appeared to be not of less value than in traditional face-to-face education. The working algorithm was proposed and implemented to overcome the limitations and challenges of e-learning in medical HEIs.

Taking into account results of the study, it is proposed for more effective education with using of digital technologies to implement the following strategies, approaches, and solutions: formation of integral digital platform, using web-supplemented education, simulation technologies, development of professional medical training, methodology of a single day.

Among number of approaches to optimize distant learning process, the use of professional medical training applications, which would support basic training, give a better assimilation of theoretical and practical knowledge for students, is proposed to implement. This can be realized through the use of mobile applications that could be made freely available. It is also proposed to establish a system of digital libraries, where relevant medical educational literature would be placed in open access. An additional factor that should optimize distance learning in medical institutions of higher education should be the introduction of a blended learning, during which theoretical knowledge can be obtained in a distance format, while practicing practical skills would take place in the traditional form (the “one-day” methodology) with use of university laboratories, stimulators, etc.

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