

ADVANCED DIGITAL TECHNOLOGIES AND APPROACHES IN TRAINING MEDICAL STUDENTS OF PROFESSIONAL EDUCATION

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Abstract

In this article, the methodology of using advanced digital technologies such as virtual reality and augmented reality in the training of medical students of professional education, the analysis of scientific research of scientists regarding the effectiveness of virtual reality and augmented reality technologies in the educational process, interdisciplinary cooperation and interprofessional education, advanced technology integration, competency-based approach, basic methodologies of competency-based educational programs, and information on technologies and aspects of Medical Education, their benefits, and applications.

Keywords: Medical education, advanced digital technologies, virtual reality, augmented reality, interdisciplinary and interprofessional education, modern approaches, online education, integration of advanced technologies, competency-based approach.

Introduction

In the decision of the President of the Republic of Uzbekistan dated 28.12.2023 "On the acceleration of digitization of the healthcare system and additional measures to introduce advanced digital technologies" No. PQ-415 [1] issues such as the preparation of project and technical documents, the development of software-hardware complexes, automated information systems, software products and engineering infrastructures, as well as the establishment of training for the employees of medical institutions on computer literacy and the use of medical information systems.

The training of medical students emphasizes the need to pay special attention to the complexities of modern health care, including not only traditional aspects of education, but also the integration of innovative methods and technologies. Effective medical education now emphasizes the development of ethical principles, professional competence, and clinical reasoning.

The training of medical students has included innovative approaches and methods to improve the educational experience and outcomes to meet the complexities of modern healthcare. A comprehensive approach to medical education emphasizes not only the acquisition of knowledge, but also the development of ethical principles, professional competencies, and clinical reasoning from the initial stages of training [2].

The use of virtual and augmented reality and simulation training, which is a part of advanced technologies, in the effective organization of the educational process in medical institutions,



which allows students to safely perform procedures, perform various surgical procedures virtually, and strengthen clinical practical skills.

Virtual Reality is a simulated environment created with the help of digital technology, in which users can communicate and perform certain actions through special devices, for example, VR glasses or control devices. These environments are usually 3D, allowing users to detach from the real world and feel as if they are in a different place or event.

Augmented Reality is a technology that adds computer-generated digital elements to the real world view that the user sees. In this case, real and virtual objects coexist, but the user is not separated from the real world. Augmented reality is often implemented through a smartphone, tablet, or special AR glasses.



M.A Fayzullaeva in her research, can conduct scientific research on the organization and development of the educational process based on 3D VR. It helps to gain more information about the presentation of educational processes and the effectiveness of teaching methods. For example, 3D VRs can be used for testing in education. This reduces the complexity of test administration and provides students with a more realistic atmosphere in the classroom than other methods. One group was taught with the help of 3D technologies, and the other group was taught without 3D technologies, based on the teacher's plan. In both cases, you can monitor the progress of students' knowledge. However, he said that you can see that the students' knowledge and interests are much higher in the lessons conducted on the basis of 3D technologies [3].

E.A. Khushbakov discussed the use of cloud technologies, virtual reality, augmented reality, the use of a 3D printer in the development of didactic materials and experimental designs, the use of digital didactics and digital educational models, projects for teachers and students, diploma theses, scientific research, etc. To do this, it is necessary to develop scientific websites. Only then, we will use digital and 3D technologies, without reducing the quality of education. When the tablet becomes an element of learning, children are more interested in the learning process. It is equivalent to combining classical education with play. As a result, the learning



process improves, assimilation, the level of education and the efficiency of personnel training increase. He put forward the opinion that the educated generation, professional personnel are the guarantee of the development of the society on a large scale [4].

The integration of technologies such as virtual reality (VR), augmented reality (AR), and simulation has revolutionized medical education by providing immersive learning experiences that allow students to practice complex procedures in a safe environment [5]. In addition, the importance of interdisciplinary collaboration to promote a holistic understanding of patient care through interprofessional education (IPE) initiatives is emphasized [6].

Interdisciplinary collaboration and interprofessional education have enriched learning by promoting a holistic understanding of patient care. The COVID-19 pandemic has highlighted the importance of flexibility and innovation in educational approaches, as well as the need to integrate eHealth and digital technologies.

It was determined that an integral approach to education is of decisive importance in the development of personal and professional potential, and the role of educational and methodological complexes developed on this basis was emphasized [7]. Interdisciplinary integration has also been recognized as effective in improving the quality of education and developing analytical and critical thinking in future medical professionals [8].

The COVID-19 pandemic highlighted the need for innovative teaching concepts, as demonstrated in a pilot project to prepare medical students for intensive care unit work, which identified opportunities and directions for improving teaching in response to the pandemic [9]. Cultural and value aspects of medical education are also considered important, promoting a value system approach to the educational process [10].

The pandemic has significantly changed the way higher education institutions teach and teach, with significant increases in online course enrollments and online certification courses signaling a shift to digital learning [11]. However, the effectiveness of online education has been questioned and emphasized the need for digital transformation and the development of relevant skills among teachers and students [12].

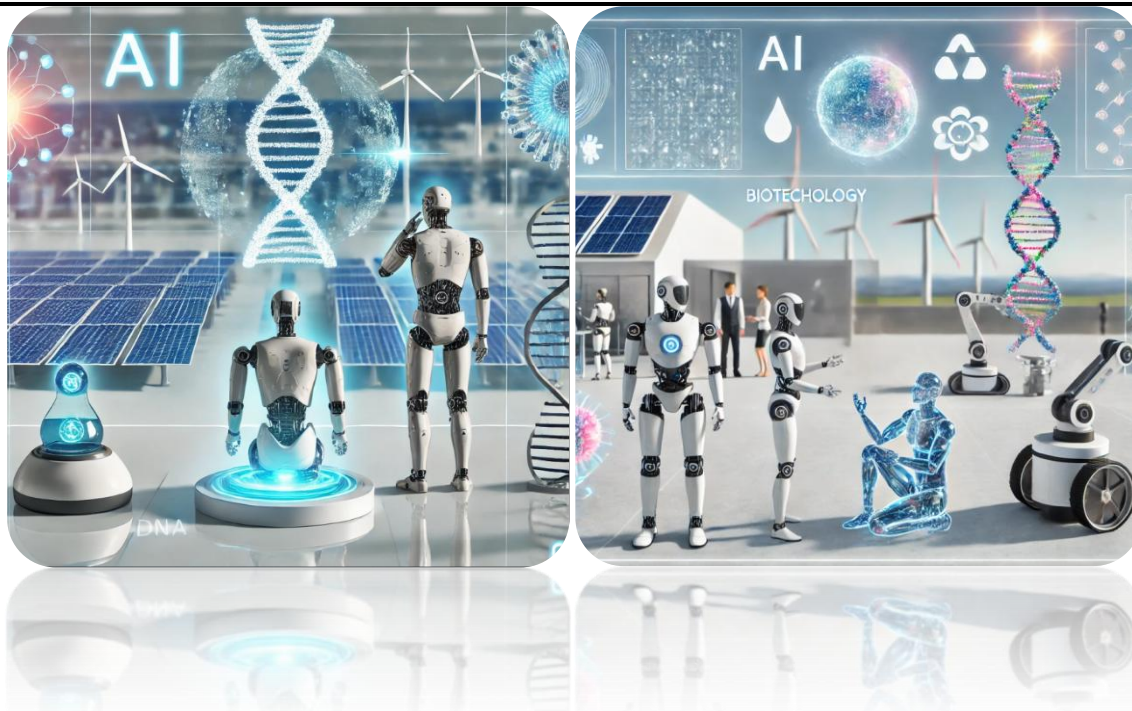
Online healthcare education is increasingly relevant, especially with the rapid adoption of technology in healthcare due to the COVID-19 pandemic, emphasizing the need for medical students to be proficient in digital healthcare technologies. is becoming [13]. The role of interactive teaching methods such as brainstorming and situation analysis in increasing students' activity and developing critical thinking is emphasized [14].

Together, these approaches aim to prepare medical students to respond to contemporary health care challenges, implying the need for continuous innovation and adaptation in medical education.

Analysis of existing approaches to training medical students reveals the integration of a number of advanced technologies necessary to adapt to the demands of modern healthcare and innovative activities.

Advanced Technology Integration Modern medical education increasingly incorporates technologies such as virtual and augmented reality and simulators, which allow students to practice clinical skills in a controlled and safe environment. These technologies offer realistic scenarios for emergency situations, surgical procedures and training in clinical practice.





The integration of advanced technologies such as virtual reality, augmented reality and simulation into modern medical education is revolutionizing the development of clinical skills by providing students with controlled and safe realistic scenarios for emergency medicine training, surgery and clinical practice. These technologies not only enhance the learning experience by providing immersive, interactive modules, but also facilitate global collaboration between medical students and professionals. The Center for Interdisciplinary Medical Education and Research is an example of these modern approaches, combining real-life medical devices with advanced simulation technologies, including VR and AR, to improve understanding of medical principles and devices in clinical settings [15]. Simulation training is indispensable in emergency medicine, especially to improve patient safety using augmented reality, to overcome the limitations of simulating dynamic changes in clinical symptoms, and to demonstrate patient emotions and actions [16]. An integrated review of modern methods in medical education shows that VR and AR technologies can be as effective and qualitative as traditional teaching methods [17].

The integration of advanced technologies into medical education reflects the development of curricula to meet the demands of modern health care and to provide medical students with the skills necessary to work in a dynamic and technologically advanced medical environment. The use of VR and AR and simulation simulators play a key role in this process.

Virtual reality immerses students in a fully simulated environment where they can experience and learn to manage a variety of medical procedures without risk to patients. This is especially valuable when teaching complex procedures such as surgery, where it is important to develop precision and confidence in one's work.

Augmented reality enriches the physical world with virtual information, allowing students to visualize anatomy and procedures directly on a model or patient, improving understanding and retention of material.



Simulation provides an authentic learning environment to practice clinical skills by simulating various medical conditions and procedures. It allows students to learn and develop their skills by working in a safe and controlled environment.

The table below provides an overview of the integration of advanced technologies into medical education:

Technology	Advantages	Application
Virtual Reality (VR)	Full immersion in a simulated environment, training in safety, complex procedures.	Training in surgical operations and clinical practice.
Augmented Reality (AR)	Improve visualization, understanding and memory of anatomy and procedures in a real-life context.	Visualization of anatomical structures, educational modules.
Simulation Simulators	A realistic environment for practicing clinical skills and simulating medical conditions and procedures.	Clinical skills training, emergency management.
Global cooperation	Overcoming geographical boundaries, sharing knowledge and experience, lifelong learning.	Collaborative research, distance learning.
Integrative (VR and AR) reviews	Comparison of effectiveness with traditional methods, cost benefit.	Analysis and improvement of educational methods.
AR Virtual Patients	Interact with a variety of clinical scenarios, improving diagnostic and treatment skills.	Teaching diagnostics and clinical reasoning.

This chart highlights the importance of integrating VR, AR, and simulation into modern medical education to provide realistic, safe, and effective learning experiences for medical students. Such technologies improve traditional teaching methods, facilitate global collaboration, and improve clinical skills, which are important for training professionals capable of working in a dynamic and technologically advanced healthcare environment.

Such an approach not only improves student understanding and engagement in the learning process, but also helps develop critical thinking and problem solving in real clinical situations. As a result, the integration of advanced technologies into medical education becomes an integral part of training experienced and qualified medical specialists who can successfully operate in modern medical practice.

The European Education Area has also recognized the need for a competency-based approach, focusing on developing key competencies such as creativity, digital literacy and critical thinking, to prepare people for the modern labor market [18].

A competency-based approach is seen as a response to the challenges of digital globalization, aiming to equip students with the skills necessary for professional activity in today's digital age. In addition, the introduction of a competency-based approach to training and professional



development of specialists is aimed at adapting educational results to the needs of the labor market, as well as focusing on the ability to act in different situations [19].

The flexibility of competency-based education programs, especially online, meets the needs of today's learners by allowing them to draw on the experiences and skills of the past. Finally, the ongoing debate and development of the concept of competence in adult education highlights the changing nature of competence standards and their important role in work performance and professional development.

Competency-based curricula represent a significant shift in medical education, moving away from the traditional focus on memorizing information and emphasizing the development of skills and competencies necessary for effective professional practice. This approach means that students should not only acquire theoretical knowledge, but also apply it in practice and adapt to the ever-changing conditions of the modern medical environment.

Competencies emphasized in such curricula include critical thinking, which enables students to analyze and evaluate data to make clinical decisions. Decision making involves the ability to solve problems quickly and effectively in an environment where many factors, including risk and benefit to the patient, must be considered.

Communication skills are also important because they enable doctors to communicate effectively with patients and their families and other health professionals. This allows for greater team understanding and collaboration, which is critical to coordinating patient care and improving the quality of care.

The ability to continue self-education and professional development is another important aspect of training medical professionals. In the rapidly developing field of medicine, the need to constantly update knowledge and skills becomes an integral part of professional life.

In this way, competency-based education programs provide the basis for training competent medical professionals capable not only of effective clinical practice, but also of continuous personal and professional growth essential to modern healthcare.

The analysis presented the main methodologies of competency-based educational programs:

1. Transition from the acquisition of traditional knowledge to the development of competencies - This methodology emphasizes the importance of not only knowledge, but also the ability to apply this knowledge in practical activities. Emphasis is placed on critical thinking, decision-making, communication skills and the ability to continuously learn.

2. Emphasis on practical application of knowledge - Programs emphasize the application of theoretical knowledge in real-world settings, which helps develop skills needed in today's work environment.

3. Assessment to achieve educational milestones - An accreditation system that requires the achievement of specific competencies necessary for professional activity reflects this approach.

4. Integrating modern competencies into curricula - For example, includes creativity, digital literacy and critical thinking to prepare for the modern labor market.



5. Development of specific competencies in various fields - Programs aimed at developing specific skills in automotive, culinary, fashion and technology that increase the competitiveness of graduates.

6. Flexibility and adaptability of programs - Competency-based learning, especially online, takes into account the needs of modern students and allows them to use their past experiences and skills.

7. Continue to update and revise competency standards - Due to rapidly evolving technology and changes in the labor market, the training program is constantly adapted and updated.

These methodologies form a modern approach to competency-based education that meets both individual development needs and the demands of the modern labor market.

The integration of advanced technology, interprofessional education, competence, flexibility, innovation, and ethical and cultural considerations in medical education are integral elements that support the development of evidence-based and analytically-based medicine. These elements help develop a deep understanding and ability to apply medical knowledge to real-world clinical practice. Let's combine these concepts into a single framework.

An integrated table of the main elements of medical education, reflecting the technologies, methodologies and aspects of medical education, their advantages, applications, as well as expected results:

Category	Technology	Advantage	Impact on medical education	Expected results
Technological integration	Virtual and augmented reality	Full penetration, safety, training of complex procedures	Surgical training, visualization of anatomy	Improving surgical intervention skills, reducing medical errors.
	Simulation simulators	Realistic training environment	Teaching clinical skills, emergency management	Improved practical skills and ability to respond quickly to a crisis.
Interprofessional education	IPE	Development of cooperation and teamwork skills	Improving the quality of patient-centered care	Strengthening team spirit, effective cooperation in medical teams
Qualified education	Program-based competencies	Development of critical thinking and communication skills	Clinical practice, interdisciplinary collaboration	Enhance professional competencies and interdisciplinary interaction
Adaptability and innovation	Online and hybrid learning	Adaptability, convenience	Prepare to meet current health challenges	Increase accessibility and flexibility of educational programs
Ethical and cultural considerations	Ethics and cultural competence	Understanding and respecting cultural diversity	Providing responsive and personalized care	Developing cultural awareness and improving patient-centered medical practice.



This chart summarizes the various elements of medical education, highlighting both technological innovation and the cultural, ethical, and competency-based aspects that play a key role in the training of modern medical professionals.

This integration highlights how medical education can be organized to support a comprehensive approach to training future medical professionals. Training that integrates these various elements prepares health care professionals not only for effective clinical practice, but also for addressing complex ethical, cultural, and systemic challenges in health care.

To conclude, advanced digital technologies and approaches to training students in the medical field of professional education allow to raise educational processes to a new level. Through digital technologies, including simulations, virtual and augmented reality (VR/AR), telemedicine platforms, and individualized curriculum modules, students will have the opportunity to put skills into practice. These approaches not only make the educational process convenient and effective, but also serve to strengthen the training of medical personnel, provide them with accurate and complete knowledge, and also develop the ability to use modern medical technologies. Also, with the help of digital technologies, opportunities to overcome the limitations of traditional education, for example, to perform complex procedures safely or to communicate with medical personnel far away, are expanding. Advanced digital approaches are of great importance in preparing students for modern medical requirements and market needs, which will help them grow as efficient and successful professionals in the future.

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