

Evolution of medical education: futurological and strategic aspects

Viktor Biryukov

Odesa National Medical University, Odesa

<https://orcid.org/0009-0002-4113-0138>

Abstract. *The work is devoted to a relevant topic – forecasting the features of the transformation of medical education in the future. The distinction is made between the futuristic method and strategic planning. The trajectories of the expected development for three main components of pedagogy are considered: acquisition of knowledge, professional skills and the ethical education. A conclusion is made about the growth of immersive teaching methodologies.*

Keywords: *medical education, futurology, strategic planning, immersive simulation.*

Distance pedagogical technologies are persistently conquering the vast market of educational services, rapidly revealing new opportunities for effective assimilation of the growing volume of information in various areas of scientific and practical activity.

One of the most conservative types of pedagogical activity is the centuries-old medical school, based on the subjective teaching experience, the authority of scientific schools, national or international consensuses and temporary protocols for the diagnosis and treatment of diseases. The conservatism of medical education and practical medical activity is determined by the social and legal responsibility of medical scientists for the effectiveness and efficiency of the technologies being implemented, the enormous importance of personal experience in medical practice, the ever-present risks of medical errors and new ethical challenges associated with the penetration of AI into all areas of human activity [1].

In this regard, the analysis of possible ways of development of pedagogy in training doctors is a relevant topic of research, allowing timely strategic planning of the medical education sector.

The purpose of this study is to analyze existing trends in higher education pedagogy and the possibilities of their adaptation for medical education.

The work uses futuristic approaches and methods of strategic planning.

A feature of the futuristic approach is the most complete collection of information about the object of study, including emerging trends in development. Such an approach allows researchers to draw a conclusion about the positive or negative impact of this object of study on the future (10-15 years or more) ecological and social environment of people's residence, man-made consequences. Often such studies have a bright journalistic coloring and are aimed at society as a whole.

In turn, the essence of strategic planning (SP) in pedagogy is to achieve certain goals in the future (up to 5 years), increasing the competitiveness or sustainability of this organization or industry in the educational services market. This activity involves monitoring and analyzing identified trends and developing logically sound steps toward achieving a goal for a specific organization or industry. SP is a dynamically structured process that includes setting goals, analyzing resources, assessing risks and opportunities, and determining the necessary actions.

Thus, the key difference between futurism and SP is its unlimited time coverage and broad view of the future, as well as the absence of specific proposals for accelerating or slowing down the development of the identified trends. The data of futuristic studies can be laid down as the basis for SP, but they are not able to suggest specific ways of implementation. Thus, globalist futurologists [2] have long predicted the replacement of human functions by robots, cybers and artificial intelligence (AI), but specific goals and ways of introducing AI into pedagogical technologies at medical faculties, tasks and timing of personnel retraining, as well as the amount of necessary technical resources and financial resources - all these elements of the strategy are within the competence of the university administration.

Trajectory of knowledge formation. The last decade has been characterized by a rapid increase in the volume of information in all areas of medicine. Thus, one of the most authoritative and popular books on pediatrics - the textbook "Nelson Textbook of Pediatrics" was published over many years with updates and reprints. In the first edition of 1956, the textbook had 1120 pages. Its 20th edition in 2015 contained 2400 pages, and the latest 22nd edition of 2024 already contains 4100 pages [3]. A huge addition to the classic clinical descriptions of diseases and illustrations of the appearance of patients in the latest editions of the textbook was the genetic component of congenital or hereditary diseases. Undoubtedly, such a trend, revealing the complex pathways of metabolism and metabolic adaptation of the human body, will continue to expand. However, this speculative material with codes of tens and hundreds of specific proteins, enzymes and controlling genes cannot be kept in human memory, much less accurately interpret the essence of health disorders at the gene and genomic levels. In clinical practice, rare, orphan diseases are rather casuistic cases when a doctor, discovering the sluggish course of the disease, the weak effectiveness of standard therapy, may suspect genetic features in his patient.

Visualization of pathophysiological processes is achieved using instrumental examination: ECG, ultrasound, CT, MRI and other methods, the interpretation of data of which also requires special skills and knowledge. Most likely, these data will be included in specialized gadgets for doctors.

The evolution of educational technologies begins, first of all, with teachers and their professional competence qualities. Modern teachers require perfect mastery of the capabilities of LMS platforms (Learning Management System), which allow you to provide,

organize, conduct and monitor online training. These platforms include, in particular, Moodle, Google Classroom, video conferencing tools Zoom and Teams, a number of specialized applications for motion analysis - Dartfish, Coach's Eye, ErgoRisk). It can be assumed that in the future, even more advanced platforms for online learning will appear.

The quality of such a learning trend will be monitored by independent experts based on objective assessment data from test assignments to students at all stages of learning. The rapid development of training based on VR- simulators (virtual reality) and immersive learning. Immersive means creating an effect of immersion, involvement. In context, immersive can refer to various areas, such as theater, training or games, where the user or viewer is actively involved in the action and feels part of what is happening.

Trajectory of skill formation. The results of medical activity largely depend not only on the correctness of decision-making, but also on the quality of the procedures performed: taking a smear for bacterial flora, atraumatic insertion of a nasogastric tube, correct fixation of a vascular catheter, accuracy of surgical sutures, correct positioning of the patient for X-ray or ultrasound examination, application of electrodes during ECG examination, etc. Knowledge of these procedures cannot replace their real, error-free execution. An incorrectly applied sphygmomanometer cuff can change blood pressure readings and cause a medical error.

The forced transition to distance education caused by the coronavirus pandemic of 2020-2021 literally caused panic among teachers of the previous formation, deprived of the opportunity to teach students practical skills in real clinical conditions. The introduction of simulation training methods quickly solved this problem and in some cases proved its advantages.

To date, simulation methodologies in medicine vary from the use of simple mannequins to complex virtual environments, allowing you to practice skills without the risk of harming the patient. The most common and consistent with anatomical and physiological concepts are simulators based on mannequins. Visually and tactilely, they represent realistic models of parts or the entire human body, which can imitate various physiological processes and reactions. On their basis, practical skills of auscultation of heart sounds and respiratory sounds in the lungs, various types of injections and punctures, catheterization, cardiopulmonary resuscitation and other skills are practiced. By now, the imitation of the anatomy of the human body has reached its peak and further development involves inlaying electronic “stuffing” into mannequins that imitates the physiological functions of organs and systems.

The next class of simulators allows for an immersive type of training, immersing young doctors in a real business and psychological environment of a business clinical atmosphere. This class includes computer simulators that create virtual environments with typical or problematic situations. They can be both simple (simulators of surgical operations and virtual patients) and very complex, helping to practice clinical management skills (simulators of entire medical institutions).

Subclasses of this type of simulators are situational and hybrid simulators designed to practice decision-making skills in conditions close to real ones. Situations are developed by teachers in accordance with the curricula and require them to be able to develop appropriate scenarios and harmoniously combine medical equipment, mannequins and role characters. Thus. Modern teachers have the opportunity to choose the necessary class of simulator depending on the specific learning goals and the level of training of students. It should be assumed that the creation of virtual reality (VR) using VR simulators will become the dominant direction in improving educational technologies in medicine. Thus, according to data for 2023, 5.1 billion dollars were spent on the development of this direction in medicine, while 4.7 billion were spent on engineering technologies and 2.6 billion dollars on the real estate market [4].

The trajectory of the formation of ethical education. This component of medical education includes modern approaches to teaching ethical principles. It covers the study of moral norms, principles, rules of conduct for health workers in interaction with patients, colleagues and society, as well as the formation of professional responsibility and biomedical ethics. Modern biomedical ethics considers a wide range of issues related to the use of medical technologies, genetic research, organ transplantation and other aspects of modern medicine. The rising cost of modern complex diagnostic and treatment methods, the impossibility of providing a wide range of medical services for the entire population violate the fairness of the distribution of medical services and give rise to social tension and the need to resolve complex moral dilemmas. It is necessary to assume a further increase in ethical issues and include ethical education and upbringing as a mandatory component of medical education. Along with the assessment of the knowledge and skills of medical graduates, a medical diploma should be accompanied by a description of the professional maturity of the university graduate, based on monitoring his or her behavioral activity.

References

1. Biryukov Viktor, Gozhenko Anatolii and Zukow Walery. Anthropoetics as a super-system approach to the study of public health. Journal of Education, Health and Sport. Online. 30 March 2025. Vol. 79, p. 59885. [Accessed 4 April 2025]. <https://doi.org/10.12775/JEHS.2025.79.59885>.
2. The Future of Health Starts Here. Stanford Medicine Health Futurists. <https://med.stanford.edu/healthfuturists.html>.
3. Nelson Textbook of Pediatrics, 2-Vol Set – International Edition: 22/e 2024 by Robert M. Kliegman. <https://prithvibooks.com/product/nelson-textbook-of-pediatrics>.
4. Sivchenko O. VR-simulators and immersive learning, 22 Oct 2023. <https://habr.com/ru/articles/769160>.