

# INNOVATIVE PEDAGOGICAL TECHNOLOGIES IN TEACHING DIAGNOSTICS OF OPHTHALMOLOGICAL DISEASES (ON THE EXAMPLE OF GLAUCOMA AND DIABETIC RETINOPATHY)

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## Abstract

In the context of digital transformation of medical education, the introduction of innovative pedagogical technologies in the training of future ophthalmologists is of particular importance. The article discusses modern educational approaches - simulation training, augmented and virtual reality (AR/VR), online platforms and distance learning courses - in the context of their effectiveness in teaching the diagnosis of glaucoma and diabetic retinopathy. Data on improving the academic performance and clinical readiness of students using interactive methods are presented. Proposals are made to improve ophthalmological education in Uzbekistan and the CIS countries.

**Keywords:** Glaucoma, diabetic retinopathy, pedagogical technologies, AR/VR, simulation training, ophthalmology, distance learning.

## Introduction

Glaucoma and diabetic retinopathy are the leading causes of irreversible blindness worldwide. According to the WHO, more than 76 million people suffer from glaucoma, and the number of patients with diabetic retinopathy exceeds 100 million [1]. Effective diagnosis of these diseases requires not only theoretical knowledge, but also developed clinical skills formed in the process of professional training.

Purpose of the study. Analysis of the effectiveness of innovative educational technologies in teaching the diagnosis of glaucoma and diabetic retinopathy.

## Materials and Methods

The methodological basis of the study was the analysis of domestic and foreign literature for 2018-2024, including meta-analyses, WHO reports, as well as data from empirical studies (Patel et al., Lee et al., Johnson et al.) [1-5]. The methods of comparative analysis, generalization and interpretation of pedagogical data were used.

## Results and Discussion

Modern research in the field of medical pedagogy convincingly demonstrate that the introduction of simulation technologies, AR / VR tools and digital educational platforms contributes to a significant improvement in the quality of training of future ophthalmologists. This is especially relevant in the context of training in the diagnosis of such complex diseases as glaucoma and diabetic retinopathy.

First of all, it is worth noting the importance of simulation training, which is currently considered one of the most effective methods for developing clinical skills in ophthalmology. Thus, the use of high-tech ophthalmological simulators, such as Eyesi, allows students to recreate the conditions of real clinical interaction with a patient, practicing ophthalmoscopy procedures, interpreting optical coherence tomography (OCT) and analyzing changes in the fundus in a fully controlled and safe environment. According to Patel et al. [4], students who were trained using simulators demonstrated an average of 35% higher scores when testing glaucoma diagnostic skills compared to the control group trained using traditional methods.

No less promising are augmented and virtual reality (AR/VR) technologies, which have become widespread in medical education in recent years. Their use allows simulating various clinical scenarios with a high degree of realism, which contributes not only to a better understanding of anatomical and physiopathological processes, but also to the formation of clinical thinking. Thus, in a study by Lee and colleagues [3], it was found that the inclusion of AR/VR solutions in the educational process increases the level of information assimilation and memorization of material by 42%, especially when studying pathologies of the retina and optic nerve.

In addition to the above, it is impossible not to note the growing importance of interactive educational platforms and distance learning courses. The use of systems such as Moodle, Lecturio, as well as specialized ophthalmological

resources provides access to multimedia educational materials, video lectures, clinical cases and test assignments. These tools allow not only to adapt the pace and format of training to the individual needs of the student, but also to partially compensate for the lack of practical clinical experience, especially in conditions of limited access to patients. However, despite the obvious advantages of the listed technologies, their widespread implementation in the educational practice of medical universities in the CIS countries, including Uzbekistan, faces a number of significant limitations. Firstly, one of the key problems remains the lack of the necessary technical infrastructure, including modern equipment, simulators and VR devices. Secondly, there is an insufficient level of digital competence of teachers, which significantly limits the effectiveness of using even already implemented solutions. In addition, the high financial costs of purchasing and maintaining AR / VR systems are often unaffordable for educational institutions. An equally important barrier is the limited number of adapted educational resources in Russian and Uzbek, which complicates the widespread dissemination of these technologies among students studying in national languages.

Thus, despite the proven effectiveness of innovative pedagogical approaches, their implementation requires an integrated approach, including technical support, improving the digital literacy of teachers, as well as state and institutional support in creating an accessible educational environment.

## **Conclusions**

Innovative pedagogical technologies (simulators, AR / VR, online training) have a significant impact on the quality of training of ophthalmology students. Their use allows to increase the level of clinical training, improve the interpretation of diagnostic data and reduce stress when interacting with patients.

## **Suggestions**

1. Introduce simulation training at all levels of ophthalmology training.
2. Develop national online courses with video materials and testing.
3. Provide digital training for teachers.
4. Create AR/VR content for visualization of glaucoma and retinopathy.
5. Expand international cooperation for access to educational innovations.

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