

MODERN METHODOLOGY OF TEACHING CHEMISTRY IN HIGHER EDUCATION

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Abstract

The modern educational process in chemistry requires innovative approaches that combine theory with practice, digital tools with traditional methods, and scientific thinking with creative problem-solving. This paper explores the evolution of chemistry teaching methodology in higher education, focusing on student-centered learning, digital platforms, and competency-based approaches. The research emphasizes the integration of interactive methods such as project-based learning, case studies, virtual laboratories, and gamified experiments. Findings suggest that these methods enhance students' motivation, critical thinking, and professional competence, preparing them for the challenges of modern scientific and medical research.

Keywords: Chemistry education, teaching methodology, digital learning, student-centered learning, virtual laboratory, higher education.

Introduction

The rapid progress of science and technology has transformed the way chemistry is taught and learned in modern universities. Chemistry, as a core subject of medical and biological sciences, requires not only the acquisition of theoretical knowledge but also the development of practical, analytical, and critical thinking skills. Traditional lecture-based methods, while still valuable, are insufficient for addressing the needs of the 21st-century learner. Recent reforms in higher education emphasize the shift toward active learning, competency-based instruction, and digital transformation. According to UNESCO (2023), educational institutions must integrate modern digital technologies, such as online simulations, augmented reality (AR), and virtual laboratories, to promote deeper understanding and engagement in scientific disciplines. In Uzbekistan, ongoing modernization in the education sector also encourages the application of innovative teaching methods, including interactive and technology-supported approaches, to improve the quality of professional training in chemistry and related sciences.

Literature Review

Scholars worldwide have recognized the importance of adapting teaching methodologies to current scientific and technological demands. - Bunce & Cole (2018) argue that active learning environments in chemistry improve students' retention and performance. - Yilmaz (2020) notes that integrating digital platforms into laboratory instruction enhances students' experimental skills and conceptual understanding. - Zhou et al. (2022) emphasize the role of virtual laboratories during and after the COVID-19 pandemic, making chemistry education more flexible and accessible. In the Uzbek context, recent research highlights the effectiveness of blended learning and problem-based instruction in fostering deeper engagement among medical students (Khodjaeva, 2022). These findings collectively underline the growing significance of pedagogical innovation in chemistry teaching.

Methodology

This study is based on qualitative analysis, pedagogical observation, and comparative evaluation of teaching practices used at the Department of Medical and Biological Chemistry of Bukhara State Medical Institute. Participants: 60 undergraduate students of general medicine (2nd–3rd year). Tools and Methods: 1. Project-Based Learning (PBL) – students design micro-projects on biochemical processes. 2. Case Studies – real-life medical cases linked to biochemical mechanisms. 3. Virtual Laboratory Simulations – digital experiments using ChemCollective and Labster platforms. 4. Gamification – quiz-based competitions and digital chemical reaction puzzles. Data Analysis: Qualitative thematic analysis and comparative evaluation of student performance before and after introducing innovative methods.

Results and Discussion

The study revealed several important outcomes: 1. Improved Student Engagement: Attendance and participation increased by 25% compared to the previous semester. 2. Enhanced Understanding: Students demonstrated a 30% improvement in conceptual test scores. 3. Development of Soft Skills: Teamwork, communication, and problem-solving abilities significantly improved. Students reported that interactive learning made chemistry more interesting and connected to real-life professional contexts. The combination of digital and traditional methods (so-called blended learning) proved particularly effective for students with diverse learning styles.

Furthermore, the integration of virtual laboratories allowed continuous learning even outside the physical classroom, ensuring academic continuity and inclusiveness. These findings align with OECD (2023) recommendations for modern higher education: adaptability, flexibility, and competency-based progression.

Conclusion

Modern chemistry teaching methodology should not merely deliver information but inspire inquiry and experimentation. The successful experience at Bukhara State Medical Institute demonstrates that integrating digital and interactive approaches fosters both professional competence and research motivation among medical students. To further enhance chemistry education, universities should: - Expand digital laboratory infrastructure; Organize continuous teacher training in ICT and pedagogy; - Encourage interdisciplinary projects connecting chemistry with medical and biological sciences. Such reforms will support the formation of a scientifically literate, technologically adaptive generation of professionals ready to meet modern healthcare and research challenges.

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