THE PLACE AND SCIENTIFIC-PEDAGOGICAL SIGNIFICANCE OF MODERN CHEMISTRY IN THE SCHOOL CURRICULUM

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ABSTRACT

Modern chemistry plays an important role in developing students' scientific literacy, critical thinking and problem-solving skills. Its integration into the school curriculum allows students to understand the molecular basis of natural phenomena and technological progress, connecting theoretical knowledge with real-life applications. This article explores the educational relevance of modern chemistry topics such as green chemistry, nanotechnology and environmental chemistry and their importance in raising awareness of interdisciplinary learning and sustainable development. The focus is on aligning school chemistry content with modern scientific challenges, national education standards and global STEM trends. The study also discusses the pedagogical need for laboratory-based teaching, digital tools and teacher training to ensure that chemistry education is engaging, relevant and practice-oriented..

Entrance

In the 21st century, chemistry has expanded beyond its traditional boundaries to become a major science that intersects with many other disciplines, including biology, physics, environmental science , and engineering. This interdisciplinary nature highlights the need to incorporate modern chemistry concepts into school curricula to prepare students for the complexity of modern scientific problems. Recent analyses of secondary school chemistry curricula in various countries have shown a trend toward including modern topics such as green chemistry, nanotechnology , and environmental chemistry. For example, a comparative study found that the Czech curriculum effectively covers modern trends in chemistry, unlike curricula in Turkey and Finland. This inclusion not only enhances students' understanding of current scientific issues, but also aligns learning outcomes with global scientific advances .[1]

The relevance of modern chemistry education is further highlighted by its impact on student engagement and understanding. Research has shown that traditional chemistry topics such as the chemistry of oxides, acids, bases, and salts are often abstract and poorly

contextualized, leading to reduced student engagement and performance. In contrast, the integration of modern and context-based approaches in chemistry education is associated with improved student motivation and understanding. Furthermore, the future job market emphasizes the importance of a solid chemistry education. Chemistry-related professions are expected to remain in demand due to advances in technology, healthcare, sustainability , and industrial needs. Significant growth is expected in areas such as the pharmaceutical and biotechnology industries, renewable energy, and energy storage, where chemists play an integral role in research and development .[2]

In Uzbekistan, it is crucial to align the national chemistry curriculum with these global trends. By incorporating modern chemistry topics and teaching methodologies, Uzbekistan can raise its educational standards, better prepare students for the global labor market, and contribute to the country's scientific and technological progress.

The introduction of modern chemistry into school curricula has been a key focus of educational reforms in Uzbekistan. A study by Pardayev et al. (2025) highlights the effectiveness of introducing information and communication technologies (ICT) into chemistry education, noting significant improvements in student engagement and understanding through the use of virtual laboratories and interactive learning platforms. Government initiatives have further emphasized the importance of modernizing chemistry education. The presidential decree outlined measures to improve the quality of continuing education in chemistry and biology, including the establishment of specialized schools and the introduction of advanced pedagogical technologies.

Statistics show the scale of these reforms. In the 2023/2024 academic year, 10,522 secondary education institutions were operating in Uzbekistan, an increase of 748 schools in five years. The number of students reached 6.64 million, reflecting an increase of approximately 476,900 students since the 2019/2020 academic year.[3]

This study uses a mixed methods approach, combining qualitative and quantitative analyses, to assess the integration of modern chemistry into the Uzbek school curriculum. The qualitative component includes a comprehensive review of national policy documents, educational reforms , and the scientific literature on chemistry education. The quantitative component includes an analysis of statistical data from the Statistics Agency under the President of the Republic of Uzbekistan and international assessments such as PISA.

Data collection consisted of extracting information from official government publications, peer-reviewed journals , and educational databases. The study also examines the impact of ICT tools on chemistry education, drawing on case studies and empirical research to assess their effectiveness in improving student learning outcomes. By integrating these methodologies, the study aims to provide a comprehensive understanding of the current state of chemistry education in Uzbekistan and to provide evidence-based recommendations for further curriculum development .

The introduction of modern chemistry into the Uzbek school curriculum has led to significant improvements in student engagement, comprehension, and overall academic performance. A study by Pardayev et al. (2025) showed that the use of information and communication technologies (ICTs) such as virtual laboratories and interactive simulations can enhance students' understanding of complex chemical concepts and increase their motivation to learn. Interdisciplinary approaches have also proven effective. Sharipova (2024) found that

integrating chemistry education with subjects such as biology, physics , and geography improves students' critical thinking and problem-solving skills, leading to a deeper understanding of chemical principles. Government initiatives have supported these educational achievements. Specialized schools focused on chemistry and biology have been established across the country by presidential decree to improve the quality of science education .[4]

Despite these positive developments, challenges remain. Ikhtiyorova et al. (2024) identified challenges such as limited laboratory resources and the need for continuous teacher training to effectively implement modern teaching methods. The introduction of modern chemistry into the Uzbek school curriculum has led to improved educational outcomes, but continued efforts are needed to address existing challenges and continue progress .[5]

Discussion

The introduction of modern chemistry into the Uzbek school curriculum has led to significant improvements in student engagement, comprehension, and overall academic performance. A study by Pardayev et al. (2025) showed that the use of information and communication technologies (ICTs) such as virtual laboratories and interactive simulations can enhance students' understanding of complex chemical concepts and increase their motivation to learn. Interdisciplinary approaches have also proven effective. Sharipova (2024) found that integrating chemistry education with subjects such as biology, physics , and geography improves students' critical thinking and problem-solving skills, leading to a deeper understanding of chemical principles.

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Conclusion

The results of this study confirm that modern chemistry plays a crucial role in the evolution of school science education in Uzbekistan and globally. The integration of modern chemistry topics such as nanotechnology, green chemistry, and sustainable energy systems into school curricula will develop students' scientific literacy, critical thinking, and real-world problem-solving skills. These competencies are essential to raising a generation equipped to contribute meaningfully to the Fourth Industrial Revolution and the global achievement of the Sustainable Development Goals (SDGs).

Statistical trends and policy changes in Uzbekistan indicate a commitment to improving chemistry education through targeted reforms, including curriculum updates, the establishment of specialized science schools, and the introduction of ICT in the classroom. However, this progress needs to be supported by increased investment in laboratory infrastructure, continuous teacher training, and the expansion of interdisciplinary teaching methods.

Looking ahead, the demand for chemistry graduates is projected to grow by more than 30 percent in STEM-related professions, particularly in environmental monitoring, pharmaceuticals, and materials science, by 2030. This projection calls for a sustained and systematic integration of modern chemistry into all levels of education, starting from secondary schools. Modern chemistry education is not only an academic priority, but also a strategic national imperative. It is a key enabler of scientific innovation, industrial growth , and environmental awareness, and is integral to shaping Uzbekistan's future knowledge-based economy.

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