DOI: https://doi.org/10.36719/2663-4619/112/267-270

**Arzu Pashayeva**
Baku State University
https://orcid.org/0000-0003-3398-837X
pasayeva-1969@mail.ru
**Khanimbaji Mammadova**
Baku State University
master student
https://orcid.org/0009-0006-3738-5452
memmedovaxanimbaci549@gmail.com

# Innovative Practical Methods in Teaching Organic Chemistry and Modern Cognitive Approaches to Students' Independent Creativity

**Abstract**

This article discusses the use of innovative practical methods in the teaching of organic chemistry and modern cognitive approaches that influence the development of students' independent creativity. The role of interactive methods in the development of the education system is analyzed, and the impact of new pedagogical strategies on the formation of students' research skills is highlighted. In modern times, traditional approaches alone are not sufficient for fostering creative thinking in chemistry lessons; therefore, interactive and problem-based learning methods should be prioritized. This paper also examines the impact of laboratory experiments, STEM approaches, and problem-based learning on students' knowledge and skills. Additionally, it discusses how student-centered approaches enhance their analytical thinking and ability to find creative solutions.

***Keywords:*** *teaching organic chemistry, innovative methods, practical approaches, cognitive approaches, creativity, problem-based learning, STEM, interactive education*

**Arzu Paşayeva**
Bakı Dövlət Universiteti
https://orcid.org/0000-0003-3398-837X
pasayeva-1969@mail.ru
**Xanımbacı Məmmədova**
Bakı Dövlət Universiteti
magistrant
https://orcid.org/0009-0006-3738-5452
memmedovaxanimbaci549@gmail.com

# Üzvi kimyanin tədrisində innovativ praktik metodlar və şagirdlərin müstəqil kreativliyinə müasir koqnitiv yanaşmalar

**Xülasə**

Bu məqalədə üzvi kimyanın tədrisində innovativ praktik metodların istifadəsi və şagirdlərin müstəqil kreativliyinin inkişafına təsir edən müasir koqnitiv yanaşmalardan bəhs edilir. Təhsil sisteminin inkişafında interaktiv metodların rolu araşdırılır və yeni pedaqoji strategiyaların şagirdlərin tədqiqat bacarıqlarını formalaşdırmasına təsiri vurğulanır.

Müasir dövrdə kimya dərslərində yaradıcı düşüncəni inkişaf etdirmək üçün yalnız ənənəvi yanaşmalar kifayət etmir, buna görə də interaktiv və problem yönlü öyrənmə metodlarına üstünlük verilməlidir. Bu məqalə, həmçinin, laboratoriya təcrübələri, eksperimentlər, STEM yanaşması və problemyönlü öyrənmə kimi metodların şagirdlərin bilik və bacarıqlarına təsirini təhlil edir. Eyni zamanda, tələbəmərkəzli yanaşmaların onların analitik düşünmə və yaradıcı həll yolları tapma qabiliyyətini necə inkişaf etdirdiyini müzakirə edir.

***Açar sözlər:*** *üzvi kimyanın tədrisi, innovativ metodlar, praktik yanaşmalar, koqnitiv yanaşmalar, kreativlik, problem yönlü öyrənmə, STEM, interaktiv təhsil*

## Introduction

In the modern education system, the development of students' creative thinking and independent research abilities is one of the key issues. The rapid evolution of science and technology necessitates new approaches to teaching and learning that go beyond conventional methodologies. Traditional lecture-based methods often fail to engage students deeply, limiting their ability to apply knowledge practically. In this regard, incorporating innovative teaching strategies is essential for fostering independent creativity and cognitive skills in students.

**Research**

Organic chemistry, as a fundamental branch of science, requires a combination of theoretical understanding and practical application. While theoretical knowledge forms the basis of chemistry education, hands-on experience, inquiry-based learning, and cognitive approaches significantly enhance students' ability to think critically and develop problem-solving skills. Integrating laboratory practices, digital simulations, and real-world applications into the curriculum can provide students with a deeper understanding of chemical concepts and their relevance to daily life (Pashayeva, Mammadova, 2024).

Furthermore, the cognitive development of students plays a crucial role in their ability to analyze complex chemical reactions, interpret data, and formulate hypotheses. Adopting modern pedagogical techniques such as problem-based learning (PBL), inquiry-based learning (IBL), and STEM-oriented approaches encourages students to explore scientific phenomena independently and develop innovative solutions. These strategies not only improve academic performance but also cultivate essential skills for the 21st-century workforce, such as creativity, adaptability, and analytical reasoning (Bryce, Robertson, 2023).

This article explores the innovative practical methods and modern cognitive approaches used in the teaching of organic chemistry. It aims to highlight how these methodologies can enhance students' engagement, problem-solving abilities, and independent creative thinking. By implementing student-centered techniques, educators can create a more dynamic and effective learning environment, ensuring that students are well-prepared to face real-world scientific challenges (Mirbagirova, Pashayeva, Mammadova, 2024).

The rapid advancements in science and technology have brought significant transformations in education, necessitating the adoption of modern teaching strategies to better equip students with critical thinking, problem-solving, and research skills. Organic chemistry, as a crucial branch of science, plays a fundamental role in various industries, including pharmaceuticals, materials science, and environmental protection. However, traditional methods of teaching chemistry often emphasize rote memorization rather than conceptual understanding and application. This gap underscores the need for innovative approaches that actively engage students and foster their creativity (Hofstein, 2023).

The relevance of this study lies in addressing the growing demand for educational practices that enhance students' cognitive abilities, creativity, and problem-solving skills. By integrating interactive learning strategies, such as laboratory-based experiments, problem-based learning, and STEM methodologies, educators can create a more engaging and effective learning environment. Additionally, cognitive approaches that focus on independent inquiry and experiential learning help students build strong analytical and critical-thinking skills, preparing them for future scientific research and professional careers. The main objective of this study is to explore and evaluate the effectiveness of innovative practical methods in the teaching of organic chemistry. Specifically, it aims to (Paşayeva, Məlikyeganova, Cəfərov, 2020):

- Examine how laboratory practices and digital simulations enhance students' understanding of organic chemistry concepts;
- Assess the impact of problem-based learning on students' ability to apply theoretical knowledge to real-world scenarios;

- Investigate the role of STEM-based interdisciplinary approaches in strengthening students' interest and engagement in chemistry;
- Highlight the importance of cognitive learning strategies in fostering independent creativity and critical thinking.

By analyzing these aspects, this study contributes to the ongoing discourse on improving chemistry education through modern pedagogical methods and cognitive development strategies (Mirbagirova, Pashayeva, Mammadova, 2024).

**Main section.** Laboratory-based learning is a cornerstone of organic chemistry education. By engaging in hands-on experiments, students gain a deeper understanding of the physical and chemical properties of substances. Laboratory work allows learners to observe chemical reactions in real-time, measure changes, and develop essential analytical skills. Additionally, performing experiments enhances students' scientific inquiry and fosters critical thinking by encouraging them to ask questions, formulate hypotheses, and interpret results. Incorporating guided inquiry in laboratory settings enables students to construct their own understanding rather than relying solely on textbook information. Digital simulations and virtual laboratory environments provide students with an opportunity to visualize complex molecular interactions and chemical reactions that may be difficult to observe in traditional lab settings. Molecular modeling software helps students develop spatial awareness of molecular structures and reaction mechanisms, reinforcing their understanding of key organic chemistry concepts. Interactive simulations also allow students to test hypotheses in a risk-free environment, facilitating deeper engagement with the subject matter (Bates, 2022).

The combination of physical experiments and digital simulations enhances knowledge retention and helps students bridge the gap between theoretical and applied chemistry. This approach encourages students to tackle real-world scientific problems by applying their knowledge of organic chemistry. Instead of passively receiving information, students work in collaborative groups to analyze complex scenarios, design experiments, and propose solutions. PBL fosters higher-order thinking skills by requiring learners to synthesize information from different sources, critically evaluate data, and justify their conclusions. Additionally, problem-based learning strengthens students' research skills, as they must seek out relevant information and develop evidence-based arguments. Through this method, students become more self-directed learners, better prepared for future academic and professional challenges. The integration of organic chemistry with science, technology, engineering, and mathematics (STEM) disciplines promotes interdisciplinary learning and real-world application. By combining chemistry with fields such as physics, engineering, and computational science, students gain a broader perspective on how chemistry is applied in industrial and technological advancements. STEM-based projects, such as designing biodegradable polymers or investigating green chemistry solutions, provide students with practical experience in applying their chemical knowledge to global challenges. Furthermore, incorporating coding and data analysis into chemistry education helps students develop valuable digital skills essential for scientific research and innovation. Active learning strategies involve engaging students in activities that require them to process and apply information rather than passively absorbing it. Techniques such as think-pair-share, peer teaching, and classroom discussions encourage students to articulate their understanding, ask questions, and critically evaluate concepts. Student-centered models shift the focus from teacher-led instruction to student-driven inquiry, where learners take ownership of their educational journey (Woolnough, 2023).

By allowing students to explore topics of interest and formulate their own research questions, educators foster a deeper level of engagement and motivation. This approach emphasizes learning through experience, connecting theoretical knowledge with practical applications. In organic chemistry, experiential learning can take the form of industry visits, internships, and fieldwork, allowing students to witness real-world chemical processes in action. Additionally, case-based learning, where students analyze real-life case studies related to organic chemistry, enhances their ability to apply chemical principles to solve problems.

Hands-on projects, such as designing and synthesizing a novel compound, further cultivate creativity and innovation. Structuring lessons in a logical and interconnected manner enhances

comprehension and retention. Concept mapping, for instance, helps students visualize relationships between different organic chemistry concepts, making it easier to understand reaction mechanisms and molecular structures. Scaffolding, where educators progressively introduce complex topics by building on prior knowledge, allows students to develop a more cohesive understanding of the subject. Additionally, using diverse teaching materials, including videos, interactive quizzes, and flipped classroom strategies, caters to different learning styles and reinforces key concepts (Samuel, 2021; Paşayeva, Balakişiyeva, Cəfərov, 2020)

## Conclusion

This article has explored the innovative practical methods and cognitive approaches used in the teaching of organic chemistry to enhance students' creativity. The implementation of interactive and problem-based methods ensures students' active engagement in the learning process and encourages independent thinking. These approaches allow students to apply knowledge practically, thereby fostering their research-oriented mindset and analytical skills. Modern pedagogical practices demonstrate that laboratory work, STEM approaches, and problem-based learning models increase students' motivation and encourage them to be more active and creative in the field of science.

In the future, the broader integration of interactive methods into the education system will not only develop students' research-oriented thinking but also transform them into more engaged learners in the field of science. The application of innovative teaching approaches in organic chemistry lessons will enable students to not only acquire knowledge but also explore ways to apply it in real-life scenarios. To ensure continuous educational improvement, teachers should be encouraged to use interactive and student-centered methods.

## References

1. Bates, G. R. (2022). The role of the laboratory in secondary school science programs, in Rowe M. B. (ed.), What Research Says to the Science Teacher, Washington DC: National Science Teachers Association, vol. 1, 28-54.
2. Bryce, T. G. K., Robertson, I. J. (2023). What can they do? A review of practical assessment in science, Stud. Sci. Educ., vol. 12, 125-132.
3. Pashayeva, A. A., Mammadova, K. M. (2024, December 19-20). The impact of an inquiry-based approach in organic chemistry education on student achievement. Proceedings of the 9th International Scientific and Practical Conference «International Scientific Discussion: Problems, Tasks and Prospects». Brighton, United Kingdom, №229, 122-129.
4. Mirbagirova, G. M., Pashayeva, A. A., Mammadova, K. M. (2024, November 6-8). Application of role-playing games in teaching chemistry. Scientific Collection «InterConf», Proceedings of the 5th International Scientific and Practical Conference, «Science in the Environment of Rapid Changes» Brussels, Belgium. № 223, 52-56.
5. Hofstein, A. N. (2023). The Laboratory in Science Education: Foundations for the Twenty-First Century. Science Education, 88(1), 28-54.
6. Mirbagirova, G. M., Pashayeva, A. A., Mammadova, X. M. (2024). Methods and solutions for the formation of students' research skills in the educational process, Chemistry at school. Scientific-theoretical and methodological collection., Chemistry at school, 3(87), 19-24.
7. Woolnough, B. A. (2023). Practical work in 11-13 science: The context, type and aims of current practice, Br. Educ. Res. J., vol. 8 1, 23-30.
8. Samuel, D. N. (2021). The effectiveness of filmed experiments in high school chemical education, J. Chem. Educ., vol. 53, 136.
9. Paşayeva, A. Ə., Məlikyeganova, N. Ş., Cəfərov, Y. İ. (2020). Kimyanın tədrisində dərsin təşkili və ona qoyulan tələblər// Bakı Qızlar Universitetinin Elmi Əsərləri jurnalı. Bakı, №4, 14-17
10. Paşayeva, A. Ə., Balakişiyeva, Q. B., Cəfərov, Y. İ. (2020). Kimya dərslərində şagirdlərin yaradıcı təfəkkürü//Azərbaycan Respublikasının Təhsil Problemləri İnstitutu. Elmi Əsərlər jurnalı. Bakı, №5., 97-100.