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MAKTABDA KIMYO FANINI O'QITISHDA ZAMONAVIY PEDAGOGIK METODLARNI QO'LLASHNING ASOSIY IMKONIYATLARI

Jumamuratov Renat Esenbaevich
Otelbayeva Muhayyo Alisher qizi

Ajiniyoz nomidagi Nukus davlat pedagogika instituti, o'qituvchi, PhD.
Qoraqalpog'iston Respublikasi Qo'ng'iro't tumanidagi 47-sonli umumiy o'rta ta'lim maktabi, o'qituvchi.

ORCID: <https://orcid.org/0009-0000-8063-5214> ORCID: <https://orcid.org/0000-0003-2091-7978>

Annotatsiya.

Ushbu ilmiy maqolada zamonaviy pedagogik yondashuvlar natijalariga asoslangan holda maktablarda kimyo fanini o'qitishda innovatsion metodlardan foydalanishning nazariy va amaliy jihatlarini muhokama qilinadi. Shuningdek, kimyo darslarida zamonaviy pedagogik metodlardan foydalanishning samaradorligi tahlil qilingan. Tahlillar shuni ko'rsatdiki, o'quvchilarning qiziqishlarini hisobga olish orqali ta'lim samaradorligini oshirish mumkin. Xususan, tegishli kimyoviy jarayonlarni kuzatish va kimyoviy reaksiyalarning borishini tavsiflash uchun uch o'lchamli (3D) kimyoviy modellardan foydalanish nazarda tutiladi. Natijada o'quvchilar mavzuning 70–80 foizini o'zlashtiradi, bu esa ularning fanga bo'lgan qiziqishini oshiradi va yangi bilimlarni egallashiga yordam beradi. Bugungi kunda maktablarda o'quvchilarning ta'lim jarayonidagi ishtirokini faollashtirish, mustaqil fikrlash qobiliyatini rivojlantirish va amaliy ko'nikmalarini shakllantirish katta ahamiyatga ega. Shu nuqtayi nazardan, maqolada muammoli ta'lim, interaktiv metodlarni qo'llash bo'yicha statistik ma'lumotlar, kimyoviy modellardan foydalangan holda loyihaga asoslangan ta'lim, axborot-kommunikatsiya texnologiyalarini joriy etish hamda laboratoriya va amaliy mashg'ulotlarni tashkil etish kabi zamonaviy pedagogik metodlar haqida asosiy ma'lumotlar yoritilgan. Tadqiqot natijalari tahliliga ko'ra, zamonaviy metodlar nafaqat o'quvchilarning bilim darajasini oshirishi, balki ularning ijodiy fikrlash qobiliyatini rivojlantirishi va dunyoqarashini shakllantirishga ham xizmat qilishi ta'kidlanadi.

Kalit so'zlar: ta'lim, kimyo, pedagogik metodlar, virtual laboratoriyalar, pedagogik mahorat, o'qitish texnologiyasi, ta'lim samaradorligi, innovatsion yondashuvlar, pedagogik tahlil, metodik tahlil, kimyoviy modellar.

ОСНОВНЫЕ ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ СОВРЕМЕННЫХ ПЕДАГОГИЧЕСКИХ МЕТОДОВ ПРИ ПРЕПОДАВАНИИ ХИМИИ В ШКОЛЕ

Жумамуратов Ренат Есенбаевич
Отелбаева Мухайё Алишер кизи

Нукусский государственный педагогический институт имени Ажинияза, преподаватель, (PhD).
Общеобразовательная школа № 47 Кунградского района Республики Каракалпакстан, учитель.

Аннотация.

В данной научной статье рассматриваются теоретические и практические аспекты использования инновационных методов преподавания химии в школах на основе результатов применения современных педагогических подходов. Также проанализирована эффективность использования современных педагогических методов на уроках химии. Проведённый анализ показал, что учёт интересов учащихся позволяет повысить эффективность образовательного процесса. В частности, речь идёт об использовании трёхмерных (3D) химических моделей для наблюдения за соответствующими химическими процессами и описания протекания химических реакций. В результате учащиеся усваивают 70–80 % изучаемой темы, что повышает их интерес к предмету и способствует приобретению новых знаний. В современных школах большое значение имеют активизация участия учащихся в образовательном процессе, развитие навыков

самостоятельного мышления и формирование практических умений. С этой точки зрения в статье освещаются основные сведения о таких современных педагогических методах, как проблемное обучение, статистические данные о применении интерактивных методов, проектное обучение с использованием химических моделей, внедрение информационно-коммуникационных технологий, а также организация лабораторных и практических занятий. Согласно анализу результатов исследования, подчёркивается, что современные методы не только повышают уровень знаний учащихся, но и способствуют развитию их творческого мышления и формированию мировоззрения.

Ключевые слова: образование, химия, педагогические методы, виртуальные лаборатории, педагогическое мастерство, технология обучения, эффективность образования, инновационные подходы, педагогический анализ, методический анализ, химические модели.

THE MAIN OPPORTUNITIES FOR APPLYING MODERN PEDAGOGICAL METHODS IN TEACHING CHEMISTRY AT SCHOOL

Jumamuratov Renat Esenbaevich
Otelbayeva Muhayyo Alisher qizi

Ajiniyaz Nukus State Pedagogical Institute, Lecturer, PhD.
Secondary School No. 47, Kungrad District, Republic of Karakalpakstan, Teacher.

Abstract.

This scientific article discusses the theoretical and practical aspects of using innovative methods in teaching chemistry in schools based on the results of modern pedagogical approaches. The effectiveness of applying these modern pedagogical methods in chemistry lessons is also analyzed. The analysis has shown that educational effectiveness can be improved by taking students' interests into account. In particular, this involves using three-dimensional (3D) chemical models to observe relevant chemical processes and describe the course of chemical reactions. As a result, students master 70–80% of the topic, which increases their interest in the subject and helps them acquire new knowledge. In today's schools, it is particularly important to encourage students' active participation in the educational process, develop their independent thinking skills, and foster practical abilities. From this perspective, the article presents key information on modern pedagogical methods, including problem-based learning, statistical data on the application of interactive methods, project-based learning using chemical models, the integration of information and communication technologies, and the organization of laboratory and practical sessions. According to the analysis of the research findings, modern methods not only improve students' knowledge levels but also contribute to the development of their creative thinking abilities and the formation of their worldview.

Keywords: education, chemistry, pedagogical methods, virtual laboratories, pedagogical mastery, teaching technology, educational effectiveness, innovative approaches, pedagogical analysis, methodological analysis, chemical models.

Introduction. Currently, modern approaches to teaching chemistry in schools are primarily shaped by an emphasis on pedagogical competence and instructional effectiveness. The application of modern teaching technologies based on these approaches helps improve educational outcomes by focusing not only on students' acquisition of knowledge but also on developing their ability to apply it in practice.

It is essential to modernize the pedagogical methods used in chemistry education, as this subject encompasses experimental and practical activities alongside theoretical knowledge. Therefore, modern pedagogical methods aim to enhance students' independent thinking, develop their scientific reasoning skills, and foster a scientific worldview.

Among the pedagogical methods employed at the present stage, interactive teaching methods play an important role in improving the quality of education. These methods strengthen collaboration between teachers and students, ensuring students' active participation in the learning process.

Additionally, problem-based learning is considered an effective approach to teaching chemistry. In this method, the teacher presents students with challenging questions and guides them toward finding solutions independently.

Drawing on their pedagogical expertise, teachers can explain the mechanisms of chemical reactions by presenting students with various scenarios and providing them with the foundational knowledge necessary to analyze these situations. As a result, students do not merely receive ready-made knowledge passively; instead, they actively seek

information and develop a deeper understanding of the subject matter.

Another important feature of modern education is the widespread use of information and communication technologies (ICT). Virtual laboratories, simulations, animations, and multimedia tools are particularly valuable in chemistry education.

Furthermore, by using animations to illustrate complex chemical processes when explaining a topic, teachers can help students develop a clearer understanding of the underlying concepts.

To this end, creating the necessary conditions for using virtual laboratories in modern chemistry classrooms makes it possible to conduct experiments virtually that would otherwise be difficult or dangerous to perform in real-world settings.

Moreover, project-based learning methods are also widely used in contemporary chemistry education.

This method develops students' independent learning skills and encourages them to conduct research. Since each student has a different level of knowledge, interest, and ability, teachers must organize the learning process accordingly. This approach improves students' academic performance and strengthens their interest in the subject.

The distinctive nature of chemistry lies in its inclusion of abstract concepts and processes that cannot be directly observed. It is difficult to help students understand concepts such as molecular structure, interatomic bonds, and reaction mechanisms through simple explanations alone. For this reason, modern pedagogical approaches are specifically aimed at overcoming these challenges. In other words, the teacher does not act merely as a provider of ready-made knowledge but as an organizer who guides students toward acquiring knowledge independently.

Constructivist theory forms the foundation of modern pedagogical approaches. According to this theory, knowledge is actively constructed by students rather than simply presented to them in a ready-made form. In chemistry education, this approach is implemented by engaging students in experimentation, observation, comparison, and drawing conclusions.

When studying chemical reactions through laboratory activities organized using modern chemistry teaching technologies, students first conduct experiments, then analyze the results, and finally identify general patterns. Throughout these activities, students must strictly comply with laboratory safety regulations. This process ensures a deep and thorough understanding of the knowledge acquired during lessons.

Among modern pedagogical approaches, competency-based education is of particular importance. Such approaches increase the effectiveness of lessons by connecting students' theoretical knowledge with practical activities. This is especially important in chemistry, as the subject is directly related to everyday life. Therefore, teachers must use real-life examples during lessons and create opportunities for students to apply their knowledge in practice.

Interactive teaching methods are widely used in modern education. These methods encourage students to participate actively in lessons, thereby developing their thinking skills. In chemistry classes, such methods are particularly effective for mastering complex topics.

The development of information and communication technologies is also creating new opportunities for teaching chemistry. Virtual laboratories, interactive simulations, and multimedia tools make the learning process more effective, thereby improving the quality of education.

Furthermore, modern approaches place particular emphasis on individualized and differentiated instruction. Since students differ in their abilities, interests, and knowledge levels, teachers must organize lessons accordingly. This approach supports the development of each student according to their individual potential.

The use of modern methods in teaching chemistry also plays an important role in fostering environmental awareness among students. Today, environmental problems are a pressing concern, and chemistry plays a significant role in addressing them. For this reason, teachers must cultivate a responsible attitude toward nature among students.

Lessons organized using modern pedagogical approaches not only deepen students' knowledge but also positively influence their personal development. In such lessons, students learn to think independently, defend their viewpoints, and draw scientifically grounded conclusions. This prepares them for successful future careers.

Modern methods in chemistry education serve not only to impart knowledge but also to cultivate environmental awareness among students, as environmental protection and the resolution of ecological problems occupy an important place in chemistry. Therefore, teachers must use modern methods to foster a sense of environmental responsibility among students.

For the effective application of modern pedagogical methods in chemistry education, it is necessary to classify them on a scientific basis and thoroughly understand the didactic potential of each method.

In the contemporary education system, pedagogical methods serve not only as means of imparting knowledge but also as important tools for developing students' intellectual and moral reasoning, engaging them in active learning, and shaping their worldview.

From this perspective, it is advisable to examine the methods used in school chemistry education from a scientific and methodological standpoint, classifying them according to several major pedagogical approaches.

Active learning methods in school chemistry education form the foundation of modern instruction and contribute to improving lesson effectiveness. Such pedagogical methods help students acquire, understand, and analyze chemical

knowledge.

By applying active learning methods in chemistry lessons, students not only acquire knowledge but also analyze and compare information and construct new understanding.

Through concept mapping as a pedagogical method, students identify relationships between chemical concepts, thereby developing their systems thinking skills.

Interactive methods are a key component of active learning. These methods promote collaboration among students. Their application in chemistry education is particularly effective for mastering complex topics. This process develops students' communication and teamwork skills.

Research-oriented methods are among the approaches most closely aligned with the nature of chemistry, as chemistry is a science that has developed through experimentation. These methods engage students in scientific research activities.

During a lesson, students may be assigned to independently investigate the properties of a particular substance. They conduct experiments, record the results, and draw conclusions. This process fosters scientific thinking and develops students' research competencies.

Problem-based learning methods play an important role in developing students' critical thinking. By applying these methods in chemistry lessons, students acquire knowledge not by passively receiving ready-made information but through the process of solving problems.

Project-based learning methods are also an important component of modern pedagogical approaches.

This method develops students' skills in working independently, conducting research, and presenting their findings. In chemistry, students investigate real-world problems through project-based activities. This approach also involves connecting chemistry with other scientific disciplines, which helps students develop a holistic scientific worldview. By applying this teaching method in chemistry lessons, students acquire knowledge through problem-solving rather than passively receiving ready-made information.

Project-based teaching methods are also an important component of modern pedagogical approaches. These methods develop students' abilities to work independently, conduct research, and present their results. Through projects in chemistry, students investigate real-world problems. This approach emphasizes the interdisciplinary connections between chemistry and other sciences.

Information technology-based methods are an integral part of modern education. In chemistry education, multimedia tools, virtual laboratories, and interactive programs are widely used. These tools enable students to visualize and understand complex processes. Such methods are particularly effective in illustrating phenomena at the atomic and molecular levels.

A reflective approach develops students' abilities to analyze and evaluate their own activities. Through reflection in chemistry lessons, students can assess their knowledge levels, identify their mistakes, and seek ways to correct them. This, in turn, improves the quality of the educational process.

A differentiated approach, on the other hand, aims to consider the individual characteristics of each student. This is particularly important in chemistry, as students' abilities and interests vary. Teachers facilitate the development of each student by assigning tasks of different levels of difficulty.

An analysis of the system of modern pedagogical methods shows that they become even more effective when applied in an interconnected manner. In other words, rather than using a single method in isolation, it is important to integrate various methods into the educational process.

Consequently, the scientific classification of modern pedagogical methods in chemistry education and their appropriate application significantly enhance the effectiveness of the learning process. Modern teaching technologies in chemistry education not only reinforce students' knowledge but also contribute to their intellectual and personal development and the formation of creative and critical thinking skills.

In the modern education system, teaching methodologies based on chemistry education technologies serve not only to impart knowledge but also to develop students' scientific thinking. From this perspective, the systematic classification of pedagogical methods in school education and their purposeful integration into teaching practices are of considerable importance.

At the present stage, methods used in teaching chemistry are classified into several groups according to their didactic objectives, the nature of educational activities, and their orientation toward learning outcomes. These methods serve to increase student engagement in the learning process.

Through the application of such methods in chemistry education, students gain a deeper understanding of theoretical concepts and develop the ability to analyze and synthesize information. These methods are especially effective when studying complex topics such as organic chemistry, chemical kinetics, and thermodynamics.

These methods also involve students in scientific research activities. A distinctive feature of chemistry is that it is an experimental science. Therefore, laboratory work, experimental research, and observation must be integral components of the educational process.

At the present stage, it is recommended to organize small-scale research projects rather than limiting instruction to conventional laboratory exercises. During lessons, students independently investigate the properties of specific chemical substances, analyze their findings, and draw scientific conclusions. This develops their scientific inquiry competencies.

Certain pedagogical methods are specifically aimed at developing students' communication skills. Through these methods in chemistry education, students have opportunities to justify their opinions, present scientific evidence, and exchange ideas with others. Discussions, debates, and group work serve precisely this purpose.

This approach also involves teaching chemistry in connection with other subjects, thereby strengthening interdisciplinary learning.

Among modern pedagogical methods, modular learning technology also occupies an important place. This technology involves dividing educational material into small, logically complete units. Each module has its own objectives, content, and assessment system.

In chemistry, this approach facilitates the gradual mastery of complex topics. As a result, students develop a deeper understanding of the subject matter, and their knowledge is formed systematically.

With the application of modern teaching methods, the assessment system is also undergoing fundamental changes.



Formative and summative assessment systems are being introduced to complement or replace traditional assessment methods. Formative assessment is conducted continuously throughout the learning process, making it possible to monitor students' development over time. In chemistry, this is accomplished through tests, laboratory work, project assignments, and oral responses. Summative assessment, on the other hand, is conducted at the end of a specific stage and serves to determine overall learning outcomes.

It should also be noted that, in the modern era, the role of the teacher has changed significantly. Today, the teacher acts not merely as a provider of knowledge but also as an organizer, guide, and motivator in the educational process. A chemistry teacher must stimulate students' interest in the subject, encourage them to conduct research, and teach them to think independently.

Consequently, the development of pedagogical methods for teaching chemistry at the present stage significantly increases educational effectiveness. In addition to improving students' knowledge, these methods contribute to their personal development and the formation of creative and critical thinking skills. This, in turn, creates a solid foundation for training competent specialists capable of contributing to future scientific and technological progress.

The effective application of modern pedagogical methods in teaching chemistry is primarily associated with their proper integration into the teaching process. Even a theoretically well-developed method will not yield the expected results if applied incorrectly in practice. Therefore, teachers must select methods based on the content of each topic, its level of complexity, and students' levels of preparedness.

Methodological approaches must be carefully considered, especially in chemistry, where it is important to make abstract concepts concrete and visualize processes that cannot be directly observed.

One of the most effective practical methods is organizing lessons around problem-solving situations. In such lessons, the teacher does not present the topic in a ready-made form but guides students toward inquiry through thought-provoking questions.

Organizing laboratory sessions in chemistry lessons is also an integral part of modern teaching methods. Whereas in the traditional approach, laboratory work was carried out solely according to instructions, in the modern approach, it should be research-oriented. Students are required to independently determine the conditions necessary to achieve a

particular result. This develops their independent thinking and scientific reasoning skills. At the same time, teaching students to strictly observe safety rules is also a crucial pedagogical task.

The use of information technology occupies a special place in modern lessons. When implementing pedagogical methods, teachers employ animations and 3D models to explain the mechanisms of chemical reactions and demonstrate molecular movement. This allows students to gain a deeper understanding of the subject matter.

Furthermore, organizing tests, virtual experiments, and interactive tasks through online platforms makes the learning process more engaging and effective. This approach also develops students' digital competencies.

Group work methods are also widely used in teaching chemistry. Students are divided into small groups and assigned specific tasks. The groups then present their results, and a general conclusion is drawn. This method develops students' skills in teamwork, exchanging ideas, and defending their points of view.

Organizing project-based activities is also important in chemistry. For example, students might collect water samples, perform simple chemical analyses, and summarize the results. Such activities not only reinforce knowledge but also cultivate a sense of environmental responsibility among students.

Implementing a differentiated approach is another important requirement of modern education. In chemistry classes, students can be assigned tasks of varying levels of difficulty. During a lesson, some students might write simple chemical reaction equations, while others solve complex problems or explain reaction mechanisms. This approach ensures that each student develops according to their individual abilities.

Among modern methods, game-based learning technologies also occupy a special place. In chemistry lessons, complex concepts can be mastered more easily through didactic games.

Furthermore, it is crucial to connect chemistry education with real-life situations. When students learn about chemical processes encountered in everyday life, their interest in the subject increases.

Enhancing motivation during lessons is also one of the key aspects of modern pedagogical methods. Teachers must create a positive learning environment by encouraging students and recognizing their achievements. This increases students' interest in learning and encourages their active participation.

These methods actively engage students, deepen their knowledge, and teach them to think independently. Most importantly, through these approaches, students begin to understand chemistry not only theoretically but also practically.

Conducting practical experiments to determine the effectiveness of modern pedagogical methods in teaching chemistry is of considerable scientific importance. Through such research, the practical outcomes of theoretically proposed approaches can be identified, and their impact on the educational process can be analyzed.

Discussions based on pedagogical experiments conducted in school chemistry education using modern teaching models suggest that interactive and innovative methods can yield better results than traditional teaching approaches.

In studies examining modern methods of organizing chemistry laboratory classes, experimental work is usually conducted using two groups: a control group and an experimental group. In the control group, classes are conducted using traditional methods, while in the experimental group, modern pedagogical methods are applied.

During the research process, students' knowledge levels, independent thinking abilities, practical skills, and interest in the subject are regularly monitored.

Analysis of the results indicates that student learning outcomes improve significantly in classes where modern methods are applied. Particularly noticeable positive changes are observed in the mastery of complex topics. Students acquire the ability not only to memorize formulas but also to understand their meaning and apply them in practice. This contributes to the long-term retention of knowledge.

Statistical analyses also indicate the advantages of modern methods. This demonstrates that modern approaches play an important role not only in knowledge acquisition but also in competency development.

Another important finding based on the experimental results is that modern methods increase student motivation. Organizing lessons in an engaging and interactive manner enhances students' interest in the subject. As a result, they participate more actively in class, seek additional resources, and conduct independent research. This is a vital factor in improving the quality of education.

The use of modern pedagogical methods in school chemistry education is one of the key factors in increasing educational effectiveness. The results of the experimental work provide practical evidence of the advantages of modern methods. Significant improvements were observed in students' knowledge levels, engagement, and independent learning skills. These findings further demonstrate the importance of integrating modern pedagogical approaches into the educational process.

However, it was also determined that teachers' qualifications, methodological preparedness, and the availability of adequate material and technical resources are crucial for the effective application of these methods.

Based on these findings, the following scientific and practical recommendations can be proposed: chemistry teachers should regularly improve their qualifications in modern pedagogical technologies; information technologies should be widely integrated into the educational process; laboratory sessions should be organized with a research-oriented focus; and differentiated approaches that consider students' individual characteristics should be applied.

It is also important to foster a positive attitude toward chemistry among students by connecting the learning

process with real-life situations.

CONCLUSION

In conclusion, the use of modern pedagogical methods in school chemistry education significantly improves the quality of education. Teachers' pedagogical skills are a primary factor in increasing student engagement during lessons. Educational effectiveness can be enhanced when teachers explain topics clearly and present essential information in ways that correspond to students' interests.

To achieve this effectiveness, it is essential to properly organize and implement innovative teaching methods. Unlike traditional approaches to teaching chemistry, innovative pedagogical methods increase student engagement by moving beyond the passive acquisition of ready-made knowledge, developing independent thinking skills, and encouraging the analysis of acquired information.

Organizing lessons with the use of information and digital technologies creates opportunities to explain complex chemical processes visually. Furthermore, laboratory and experimental activities develop students' research skills and help connect theoretical knowledge with practical applications.

Overall, the use of modern pedagogical methods makes chemistry education more engaging, understandable, and effective.

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