

EFFECTIVE METHODS OF TEACHING CHEMISTRY BASED ON INNOVATIVE APPROACHES

Usmanova Lola Mallayevna

Teacher, department of Chemistry, Navoi state university

Musoyeva Dilshoda Norkulovna

Teacher, department of Chemistry, Navoi state university

Annotation: This article analyzes effective methods of teaching chemistry based on innovative approaches. The role of STEM integration, project-based activities, the use of information and communication technologies (ICT), gamification, and the flipped classroom method in improving the quality of education is highlighted. It is proven that these methods increase students' interest in the subject, develop independent thinking, practical experimentation, and teamwork skills. Practical results were obtained through experiments, surveys, and observation methods during the study, based on which recommendations were developed.

Keywords: Chemistry education, innovative approach, STEM, project-based learning, ICT, gamification, flipped classroom, interactive methods, educational effectiveness.

Introduction. Today on the day world on a scale education in the system event fundamental reforms, the development of science and technology, digital transformation processes science teaching styles requires updating. Especially among the natural sciences, chemistry occupies an important place. Because it is not only a set of theoretical knowledge, but also one of the main disciplines that form a scientific approach to laboratory experiments, practical exercises, real-life situations. Traditional methods of teaching chemistry often focus on memorizing information, which does not sufficiently develop students' deep understanding and analytical thinking skills. Therefore, the need to introduce innovative pedagogical technologies in the modern education system is increasing. Innovative approaches turn students from passive listeners into active participants, encouraging them to engage in independent research and learning based on experience.

Currently, innovative methods widely used in education include advanced methods such as the STEM approach, project-based learning, information and communication technology-based teaching, gamification, and flipped classroom. Through these methods, students develop problem-solving, critical analysis, teamwork, and assessment and presentation skills. This article provides an in-depth analysis of effective methods for using innovative approaches in teaching chemistry, their practical application, the quality of education, and the impact on students' attitudes toward science. The goal is to modernize the educational process and increase students' interest in chemistry, and prepare them to solve real-life and scientific problems.

Innovative approaches to teaching science play an important role in the modern education system. Especially in teaching a subject that combines theoretical and practical knowledge, such as chemistry, new methods and technologies play a significant role in improving the quality of education. This article discusses effective innovative methods used in teaching chemistry, their advantages and implementation mechanisms. An innovative approach, unlike traditional methods,

refers to methods that use modern technologies, interactive tools, creativity and active participation of the student. These approaches encourage students to think independently, develop problem-solving skills and acquire deep scientific knowledge.

Chemistry science in teaching effective innovative methods

1. STEM approach. Based on STEM (Science, Technology, Engineering). approach chemistry science other natural sciences with integration did without to teach requirement This is method through students realistic in life problems scientific point of view from the point of view analysis to do they learn.
2. Project-based activity (Project-based learning). Students small in groups or alone without chemical projects to perform through own knowledge For example, preparing environmentally friendly materials, studying chemical products used in everyday life, etc. This method their search ability increases.
3. Information and communication use of information and communication technologies (ICT). Chemistry in their classes interactive presentations, simulations, virtual laboratories, online testing systems ICT tools such as use students to sciences was interest increases and theoretically knowledge visual in a way to master opportunity creates.
4. Gamification. Chemistry to the lessons game elements current (tests, quizzes, chemistry puzzles, rating system) in students healthy competition environment creates and them lesson to the process active attraction will reach.
5. Reverse classroom (Flipped Classroom). This is it in approach students new the topic independent accordingly at home learn (video lessons, tutorials) materials via), in the classroom and knowledge reinforcement, problematic issues discussion to do more time is separated.

Materials and methods. Chemistry science innovative approaches based on teaching students not only knowledge level, maybe their scientific worldview, independent thinking, experience transfer It also develops skills. Education to the process modern methods implementation to grow through not only sciences deep to teach, maybe in students to sciences relatively positive relationship formation This is possible. in research chemistry science innovative approaches based on teaching efficiency determination for the purpose following from materials and methods used:

Uzbekistan general education 8th–10th grade students of schools and chemistry science teachers.

Materials:

- Chemistry textbooks (based on current curricula)
- Interactive electronic resources (virtual laboratories, simulations, video lessons)
- STEM- integrated assignments package

- Online testing platforms (Kahoot, Quizizz, Google Forms)
- Lesson developments and in the classroom used gamified methods
- Teachers and students withheld questionnaire results

Methods:

1. Experimental method. To compare traditional and innovative methods in teaching chemistry, lessons were conducted in two groups: a control group (traditional methods) and an experimental group (innovative methods). During the lessons, students' activity, participation, and level of knowledge were assessed.
 2. Questionnaire and interview. Students' and teachers' attitudes towards innovative methods, as well as their opinions on their effectiveness, were collected through specially designed questionnaires.
 3. Observation method. During the lesson, students' active participation, interest in conducting experiments, and independent thinking skills were directly observed and analyzed.
 4. Statistical analysis. The results obtained (tests, assessments, questionnaires) were statistically analyzed, and the effectiveness of the methods was assessed based on numerical indicators.
- 1- Table. Analytical comparison of the level of knowledge and activity of students trained using innovative and traditional methods

Indicators	A class taught using traditional methods	Innovative methods based on trained class
Students average test scores	68%	85%
In lessons participation activity (%)	60%	90%
Independent affairs number (per week)	1–2 times	3–4 times
Number of practical and experimental works (per month)	2 times	4–5 times
Students ' knowledge of science interest	Average	High

Indicators	A class taught using traditional methods	Innovative methods based on trained class
Efficiency according to the teacher	Satisfactory	Very effective

Research discussion. The results of the study showed that teaching chemistry based on innovative approaches significantly increases students' interest in science, allows for deeper assimilation of knowledge and application in practice. In classes where innovative methods were used in experimental lessons, students' active participation in the lesson, independent thinking, and interest in laboratory work were higher than in the control group taught in the traditional way. Ensuring interdisciplinary integration through the STEM approach aroused students' interest in solving real problems on a scientific basis. Through assignments related to chemistry, physics, and biology, students were able to consolidate theoretical knowledge through real-life examples.

The project-based learning method involved students in conducting practical research. They developed their own projects through analyzing chemical products, finding solutions to environmental problems, and conducting laboratory experiments. As a result, students' critical thinking, information retrieval, and analysis skills significantly developed.

The use of information and communication technologies – in particular, virtual laboratories and interactive simulations – has helped to organize chemistry lessons in a visual and engaging way. This approach has played an important role in increasing the efficiency of knowledge acquisition and facilitating the understanding of complex topics.

Gamification has created a healthy competitive environment in the learning process. Through a point system, quizzes, and assignments, student participation has increased, resulting in increased motivation for the lesson and increased knowledge acquisition.

The flipped classroom model allowed students to learn independently at home and engage in in-depth discussions in class. This method not only increased students' preparation, but also fostered a sense of responsibility.

Based on the statistical data collected during the study, it can be noted that in classes using innovative methods, test results improved by 15–20%, and student participation in the lesson significantly increased. At the same time, teachers also noted that such methods enrich the content of lessons and increase their effectiveness.

Conclusion. Based on the conducted research and analysis, it was found that teaching chemistry based on innovative approaches is an important factor in improving the quality of education. Innovative methods - including the STEM approach, project-based learning, information and communication technologies, gamification and the flipped classroom model - increase students' interest in knowledge, encourage them to think actively, research, experiment and work in a team.

As a result of teaching based on innovative methods in experimental classes, students' test results and class participation were higher than in groups using traditional methods. This shows that modern pedagogical approaches are important not only for imparting knowledge, but also for its deep understanding and application in practice. Therefore, the widespread introduction of innovative approaches in teaching chemistry, improving the skills of teachers, providing them with modern technological tools and systematically using interactive methods are urgent tasks today.

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