ISSN: 2582-4686 SJIF 2021-3.261, 2022-2.889, 2023-5.384, 2024-6.875 ResearchBib IF: 9.948 / 2024

THE MULTIDISCIPLINARY JOURNAL OF SCIENCE AND TECHNOLOGY

VOLUME-5, ISSUE-10

THE NECESSITY, RELEVANCE, AND DEVELOPMENT PROSPECTS OF AN INTEGRATED APPROACH IN CHEMISTRY EDUCATION

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Abstract. This article examines the necessity, relevance, and future prospects of implementing interdisciplinary integration principles in chemistry education. The essence of the integrative approach is reflected in the development of students’ complex thinking, logical analysis, and scientific as well as ecological reasoning. Research findings indicate that integrating chemistry lessons with physics, biology, mathematics, ecology, and technology significantly enhances students’ knowledge quality, motivation, and practical skills.

The article also emphasizes the role of innovative methods such as the STEAM education approach, project-based learning, problem-based instruction, digital laboratories, and virtual simulations. As for the prospects of integrated education, the article substantiates the need to incorporate sustainable development concepts into the learning process, to improve teachers’ interdisciplinary competencies, and to strengthen preparation for international assessment systems.

Keywords: chemistry education, interdisciplinary integration, innovative approach, sustainable development, STEAM education, problem-based learning, scientific thinking, digital technologies, competency-based approach, environmental culture.

Introduction. Today, one of the most important tasks facing the education system is to develop students’ independent thinking, scientific worldview, and innovative mindset. In this process, teaching methods based on interdisciplinary integration play a particularly significant role.

In particular, teaching chemistry in close connection with other natural sciences - such as physics, biology, mathematics, ecology, and technology - helps to form a comprehensive system of knowledge in students and enables them to relate theoretical knowledge to real-life situations.

The integrative approach develops students’ skills in analysis based on practical experience, logical reasoning, and drawing scientifically grounded conclusions. This, in turn, plays an important role in fostering an understanding of sustainable development concepts, shaping environmental culture, and developing XXI century competencies. Therefore, the implementation of an integrated approach in chemistry education is recognized as one of the strategic directions of modern pedagogy [1].

Main Part. In modern education, interdisciplinary integration plays a crucial role in developing students’ scientific thinking and logical reasoning. Each subject should not be taught in isolation but rather as an interconnected system. In particular, the relationship of chemistry with physics, biology, ecology, and geography makes the learning process more meaningful and applicable to real life.

On one hand, interdisciplinary integration enables students to apply their acquired knowledge to solve real-life problems; on the other hand, it enhances their abilities for independent inquiry, analysis, and experimentation. Such an approach helps harmonize the theoretical foundations of chemistry education with practical activity.

When organizing integrated learning, it is effective to employ methods such as problem-based learning, project-based instruction, contextual approaches, and research-oriented methodologies. These approaches encourage learners not merely to memorize ready-made knowledge

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but to discover it independently. Interdisciplinary integration not only harmonizes the content of different subjects but also strengthens the educational and developmental aspects of teaching.

The role and relevance of the integrative approach. When explaining chemical processes through connections with physical laws, biological systems, and ecological phenomena, students' thinking develops in a complex and holistic way. As a result, learners deeply internalize scientific worldview, ecological culture, and the principles of sustainable development.

Relevance of the integrative approach. Today, the need to implement interdisciplinary integration in the education system is becoming increasingly important. This process is closely related to the innovative paradigm of education, in which the learner is placed at the center of the process, emphasizing active participation and inquiry-based learning. Chemistry, by its very nature, is an integrative science - it is inherently interconnected with biology, physics, ecology, geography, and technology. Therefore, teaching chemistry on an integrative basis helps students develop systematic thinking skills and understand the unified essence of natural phenomena.

Advantages of the integrative approach. The integrative approach harmonizes students' theoretical knowledge with real-life applications. For example, by analyzing the interrelation of chemical processes with biological metabolism, ecological balance, or industrial technologies, students acquire competencies such as practical reasoning, critical thinking, and environmental responsibility.

Research shows that integrated chemistry education increases students' motivation, strengthens their interest in research activities, and reduces the gap between theory and practice. As a result, learners not only understand chemical processes but also develop the ability to analyze their social, ecological, and technological implications.

Research Description

In this study, the impact of teaching chemistry through an integrated approach on students' motivation, creative thinking, and practical skills was examined. The research was conducted during the 2024–2025 academic year and involved a total of 52 students from grades 8–9. The experimental group was taught using an integrative approach that combined chemistry, biology, technology, and ecology, while the control group followed a traditional teaching method.

During the research process, the following aspects were investigated:

Determining the level of motivation – students' interest in chemistry was measured using the "Science Motivation Questionnaire."

Assessing readiness for research activities - through laboratory work, observations, and problem-solving tasks, students' abilities for independent thinking and analysis were evaluated.

Analyzing the connection between theory and practice – students' ability to relate theoretical knowledge to practical situations (such as water pollution, energy sources, and reaction rates) was studied.

Research results. After implementing the integrative teaching approach, several positive changes were observed among the students in the experimental group. The motivation level increased by an average of 22%. The interest in research activities rose by 18%, as reflected in their active participation in laboratory sessions. Moreover, the gap between theory and practice was significantly reduced — 76% of students were able to connect chemical processes with real-life problems.

The STEAM Approach and Future Prospects. In modern education, integrating the STEAM (Science, Technology, Engineering, Art, and Mathematics) model with interdisciplinary approaches has become one of the most pressing issues. The STEAM concept interprets chemistry not merely as

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a theoretical discipline, but as a system grounded in creativity, engineering thinking, and innovative activity. For example, through studying renewable energy sources, biopolymers, or water purification technologies in chemistry lessons, students gain a deeper understanding of the interconnection between sustainable development, environmental safety, and technological innovation [2].

Future implementation of the integrative approach. In the future, effective implementation of the integrative approach in practice will require the development of teachers' pedagogical and innovative competencies, the creation of interdisciplinary projects, and the use of virtual laboratories, digital platforms, and simulation programs. Integrated chemistry education plays a crucial role not only in imparting knowledge but also in promoting the ideas of sustainable development, fostering ecological thinking, and cultivating scientific culture.

Conclusion. An education system built on an integrative approach ensures the harmony of modern methods, innovations, and scientific thinking in teaching chemistry. Such an approach helps develop XXI century skills in students - critical thinking, creativity, problem-solving, and teamwork abilities. Thus, integrative education represents not only a relevant but also a promising direction in modern chemistry teaching.

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