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SOME ISSUES OF CHEMISTRY TEACHING IN THE CONTEXT OF ITS METHODOLOGICAL PROBLEMS

Jumanov Akhmadjon Mirzaevich
Associate Professor, Department of Chemistry and Ecology,
Kokand State University, Republic of Uzbekistan

Abstract
This article discusses key issues of chemistry teaching in the context of modern methodological problems of chemical science. The role of chemistry in the system of natural sciences and its relationship with physics and biology are highlighted. The importance of chemical atomism, educational standards, and the improvement of chemistry education is emphasized. Particular attention is paid to experimental training, interdisciplinary integration, and modern educational technologies. The study underlines the significance of developing chemical literacy, culture, and thinking.

Keywords: Chemistry education, methodology of chemistry, chemical atomism, chemical literacy, interdisciplinary relations, chemical thinking, educational standards.

Introduction

Annotatsiya. Maqolada kimyo fanini o‘qitishning zamonaviy metodologik muammolari yoritilgan. Kimyoning tabiiy fanlar tizimidagi o‘rni hamda fizika va biologiya bilan aloqalari tahlil qilingan. Kimyoviy atomistika va kimyo ta’limi mazmunining ahamiyati ko‘rsatib berilgan. Shuningdek, eksperimental tayyorgarlik, fanlararo integratsiya va zamonaviy ta’lim texnologiyalariga e’tibor qaratilgan. Kimyoviy savodxonlik va tafakkurni rivojlantirishning dolzarbligi asoslangan.

Kalit so‘zlar: kimyo ta’limi, kimyo metodologiyasi, kimyoviy atomistika, kimyoviy savodxonlik, fanlararo aloqalar, kimyoviy tafakkur, ta’lim standartlari.

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Аннотация

В статье рассматриваются актуальные методологические проблемы преподавания химии. Показана роль химии в системе естественных наук и её связь с физикой и биологией. Раскрывается значение химической атомистики и содержания химического образования. Особое внимание уделено экспериментальной подготовке, межпредметным связям и современным образовательным технологиям. Подчеркивается важность формирования химической грамотности и химического мышления.

Ключевые слова: химическое образование, методология химии, химическая атомистика, химическая грамотность, межпредметные связи, химическое мышление, образовательные стандарты.

Chemistry, as one of the fundamental sciences within the natural sciences, is developing and improving intensively. The “information boom” that has encompassed all humanity has significantly affected chemistry and chemical technology as well. The field of research of this science is extremely broad, since it closely interacts and productively cooperates with physics on the one hand and biology on the other. Chemical transformations are based on physical processes involving the movement of atoms, transitions from one molecular structure to another, and changes in the states of electron shells of atoms and molecules.

Based on these considerations, some physicists have advanced the thesis that chemistry is completely absorbed by physics and possesses no specific features of its own. Such a viewpoint is nothing more than a manifestation of physical “chauvinism.” Chemical phenomena are far more complex processes; even the simplest chemical act cannot be fully explained by physics alone. Although the physicalization of chemistry is one of the characteristic features of modern chemical development, and the influence of physics is diverse and encompasses a wide range of theoretical and experimental chemical issues, it should be emphasized that physics cannot assume the task of explaining the entire chemical world. Nevertheless, it provides invaluable assistance in solving this task.

In turn, chemistry exerts a productive influence on biology and helps reveal the secrets of life processes. Biology incorporates both physics and chemistry as its most important components. The direct transfer of chemical methodology into

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biology and the errors that followed led to accusations of mechanistic thinking and reductionism. From the standpoint of the methodology of scientific cognition, biological sciences are currently considered less advanced in their research methods than the physical and chemical sciences. Experimental methods are less developed in biology than in physics. Therefore, the study of living objects using chemical methods has gradually passed into the hands of biologists, resulting in a diverse conglomerate of scientific disciplines. However, in all cases chemistry retains its own identity. Even in interdisciplinary sciences such as physical chemistry and biochemistry, chemical processes are clearly expressed and determine the specificity of these fields.

According to the well-known statement of the English scientist and historian of science, John Desmond Bernal, who is also regarded as one of the founders of science studies, modern chemistry rests upon “three pillars”: the theory of the structure of matter, chemical thermodynamics, and chemical kinetics. Fortunately, although these pillars “float and exist” within the boundless ocean of science, they do not dissolve into it.

Scientists divide the methodological problems of modern chemistry into three groups: ontological, epistemological, and social. All of them are interconnected and interdependent. From an individual substance to its class, from the particular to the general, and from the individual to the mass—this is the dialectical path of chemical cognition of the objective material world. Like any science, chemistry must primarily serve society and humanity. Modern civilization cannot exist without the contributions of chemistry.

Chemistry extends its influence to the solution of the following global challenges:

1. Ensuring food security, increasing livestock productivity and agricultural yields, as well as improving the storage and processing of raw materials and food products.
2. Addressing energy supply issues, developing environmentally friendly fuels, and utilizing renewable energy resources.
3. Environmental protection.
4. Development of safe and waste-free production technologies.
5. Health protection, disease treatment, and prevention.
6. Integration of chemical technology with biotechnology.
7. Development of regenerative chemistry.

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8. Technological resource conservation.
9. Coordination of macro- and microtechnologies with nanotechnology.
10. Replacement of metallic materials and raw materials with nonmetallic polymers and plastics.

These and many other issues should be reflected in the content of chemistry courses within the system of continuous education.

State Educational Standards (SES) for general secondary, specialized secondary, vocational, and higher education, developed and implemented in practice, are continuously being improved, dynamically developed, and tested in accordance with the requirements of the Law on Education and the National Program for Personnel Training of the Republic of Uzbekistan.

The theoretical foundations of chemistry courses include:

a) atomic-molecular theory;
b) fundamental stoichiometric laws;
c) structure of matter and chemical bonding;
d) theory of electrolytic dissociation;
e) the periodic law and the periodic system of chemical elements;
f) the theory of solutions;
g) oxidation-reduction processes;
h) rates of chemical reactions and chemical equilibrium;
i) the theory of the structure of organic compounds, and others.

Among these topics, a special place belongs to chemical atomism, which not only determined the fate of chemistry but also exerted one of the decisive influences on the development of natural science as a whole. The ideas of chemical atomism, originating from the works of the great English scientist John Dalton, should run like a red thread throughout the entire chemistry curriculum. Dalton is also well known for his studies of color vision. In this regard, one cannot fail to recall the famous words of the American physicist and Nobel Prize laureate Richard Feynman, who accurately assessed the role of atomism in the history of science: "If, in some cataclysm, all scientific knowledge were to be destroyed, and only one sentence could be passed on to future generations of living beings, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis…"

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The current State Educational Standards in chemistry attempt to formulate requirements for the knowledge and skills acquired in each course:

1. Knowledge of a theoretical nature (concepts, laws, regularities, principles, and theories);
2. Knowledge related to the language of science;
3. Knowledge of a worldview nature;
4. Knowledge of the most important facts of chemistry;
5. Skills in carrying out mental operations and logical thinking;
   Practical skills and competencies.

Unfortunately, these regulatory documents are still far from perfect. Therefore, there is a need to prepare new editions and modernize them.

Under current conditions, teachers and students face a number of organizational-didactic, scientific-theoretical, and methodological tasks:

1. Ensuring mass chemical literacy.
2. In-depth study of the theoretical foundations of chemistry.
3. Mastering the techniques and methodology of chemical experimentation, the principal practical method of teaching chemistry.
5. Solving problems, exercises, and test assignments.
6. Improving and strengthening the material resources of chemical education.
7. Enhancing the contribution of extracurricular activities to the lesson, which remains the primary organizational form of instruction.
8. Broad inclusion of local materials and reflection of achievements in chemistry, the chemical industry, and chemical technology attained during the years of independence of the Republic of Uzbekistan.
9. Implementation of modern educational technologies.
10. Systematic inclusion of facts and materials from the history of chemistry to reveal more fully the genesis of chemical knowledge.
11. Strengthening the practical orientation of chemical education.

Interdisciplinary connections are of great importance for improving the educational process. The successful implementation of these connections contributes to solving many educational tasks: achieving meaningful learning, ensuring the durability of knowledge, teaching students how to apply knowledge, developing cognitive activity, and forming a scientific worldview. The

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relationship of modern chemistry with physics and biology should also be reflected in the content of chemical education.

The correct and scientifically grounded organization of chemistry teaching should ultimately lead to the eradication of chemophobia the negative public perception of chemistry among the population strengthening the role of constructive chemistry in improving societal well-being and, conversely, reducing the harmful effects of destructive chemistry on nature and society.

Taking into account the contemporary methodological problems of chemical science, it is necessary to organize chemistry teaching processes competently and effectively. Only in this way can the formation of mass chemical thinking, chemical culture, and chemical consciousness be achieved.

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