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THE THEORETICAL, HISTORICAL, AND EDUCATIONAL FOUNDATIONS OF BIOLOGY TEACHING METHODOLOGY

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ABOUT ARTICLE

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Abstract: The article examines the theoretical, historical, and methodological foundations of biology teaching in modern education. It highlights the role of competency-based and active learning in developing students' scientific thinking, environmental awareness, and practical competencies. The educational ideas of al-Farabi, al-Biruni, Ibn Sina, and the Jadid movement are considered. Effective biology teaching contributes to developing independent, scientifically minded, and responsible individuals.

Introduction. The methodology of teaching biology is a comprehensive scientific and practical field that occupies an important place in the modern system of pedagogical sciences and scientifically studies the content, objectives, tasks, methods, and organizational forms of biology education. This discipline not only determines ways of effectively conveying the content of biology to students but also studies the processes of their learning, education, and development in an interconnected manner. The main objective of the methodology of teaching biology is to organize biological education based on modern requirements, form students' scientific knowledge about living nature, connect it with practical activities, and develop environmental awareness and culture.

This discipline reveals not only the content of biology education but also its didactic essence. Because biology is not merely a collection of facts and concepts, but a scientific system that explains processes in living nature and reveals the interrelationship between humans and nature. Therefore, the methodology of teaching biology, along with forming biological knowledge in students, also performs such tasks as developing their scientific worldview, forming critical and independent thinking, and fostering a conscious attitude toward the environment [2].

The methodology of teaching biology as a science studies the processes of students' learning, education, and development as a unified system. In the process of acquiring biological knowledge, a student passes through the stage from simple observation to a scientific conclusion. During this process, the student performs such mental activities as analysis, synthesis, comparison, and generalization. As a result, biological concepts are formed and consolidated in their consciousness. At the same time, biology education serves to develop students' personal qualities—responsibility, love for nature, environmental awareness, a healthy lifestyle, and other aspects.

Literature Review. Theoretically, the methodology of teaching biology develops the general laws of biological education, while practically it serves the teacher's daily activities. Lesson planning, selecting methods, presenting educational material clearly, using visual aids, and organizing the assessment system constitute the practical aspect of the methodology. Therefore, mastering the discipline of methodology thoroughly is considered one of the main conditions for developing the professional skills of a biology teacher [3].

This discipline also includes contemporary issues of assessment and diagnostics within its scope of research. Because the study of the processes of learning, education, and development cannot be complete without assessment. In the methodology of teaching biology, assessment now requires not only determining whether a student has memorized a topic, but also determining how deeply the student understands a biological concept, whether they can apply it in a new situation, work with evidence, and draw conclusions related to environmental and healthy-lifestyle issues. International assessment approaches have strengthened precisely this aspect. PISA and similar approaches consider scientific literacy, that is, the ability of a student to apply scientific information to understanding and solving problems in everyday life, nature, and society, more important than merely remembering facts. Therefore, under modern conditions, the methodology of teaching biology also encompasses competency-based approaches, active learning, evidence-based conclusion-making, and authentic assessment [4].

An analysis of local and foreign literature on the methodology of teaching biology shows that this discipline ensures that biology education is organized in the unity of its content, educational, and developmental dimensions. While methodological sources describe the purpose of biology education as equipping students with scientific knowledge about living nature, forming a conscious attitude toward nature, and developing biological thinking, international sources place particular emphasis on active learning, experimental evidence, interdisciplinary connections, and deep understanding. Harmonizing these two directions is particularly important for today's biology teacher. Because modern biology education is being formed at the intersection of national educational objectives, methodological traditions, and international educational requirements.

First of all, one of the most important areas of biological knowledge is related to maintaining and strengthening human health. Knowledge about the structure and functioning of the human body, physiological processes, hygiene rules, disease prevention, and the principles of maintaining a healthy lifestyle constitutes the main content of biology. This knowledge not only forms theoretical concepts in students but also develops skills necessary in practical life. For example, habits such as proper nutrition, maintaining physical activity, avoiding harmful habits, and observing personal hygiene are consciously formed precisely through biology education. The development of modern medicine and the healthcare system is also based on biology, because the etiology, pathogenesis, and prevention of diseases are explained on the basis of biological laws. Therefore, biological literacy is considered one of the important factors in ensuring public health.

Research Methodology. Another important aspect of biological knowledge is its close connection with scientific and technological progress. In the twenty-first century, new fields of biology, including genetics, molecular biology, biotechnology, bioinformatics, and ecology, are developing rapidly. These fields not only enrich theoretical science but are also widely applied in such areas as production, agriculture, medicine, and pharmaceuticals. For example, genetic engineering is used to create high-yield and disease-resistant plant varieties, new medicines are developed from biologically active substances, and environmentally friendly technologies are introduced using microorganisms. In addition, bioinformatics expands the possibilities of identifying and treating hereditary diseases through the analysis of genomic data. This clearly demonstrates the strategic importance of biology in scientific and technological advancement [8].

In the modern education system, teaching biology on the basis of State Educational Standards (SES) and curricula is an important factor in ensuring the consistency, systematic

nature, and quality of education. The SES serves as the main regulatory document defining the objectives and content of biology education, expected learning outcomes, and assessment criteria for students. Through these standards, biology education becomes not accidental but a scientifically grounded, clearly planned, and progressively developing system. Therefore, the SES is an important instrument that provides methodological direction in teaching biology, regulates teachers' activities, and standardizes students' levels of knowledge.

The content of biology education consists of several important components based on the SES. Among them, biological concepts, scientific ideas, laws, facts, and methods of scientific inquiry occupy a special place. Biological concepts are a system of generalized knowledge about living nature and serve as the main foundation for forming students' scientific thinking. For example, through the concept of the "cell," students understand the structural basis of all living organisms; through the concept of the "organism," they understand the integrity of a living system; and through the concepts of "population" and "ecosystem," they comprehend the complex structure and interrelationships of biological systems. These concepts are not simply pieces of information but fundamental units of knowledge that shape students' biological worldview [5].

Comparison of the Educational and Upbringing Views of Eastern Thinkers

Criterion	Abu Nasr al-Farabi	Abu Rayhan al-Biruni	Abu Ali ibn Sina
Period	9th–10th centuries	10th–11th centuries	10th–11th centuries
Main direction	Philosophy, logic, politics, pedagogy	Natural sciences, astronomy, geography, scientific methodology	Medicine, philosophy, psychology, pedagogy
Purpose of education	To lead a person toward happiness and form a perfect individual	To understand scientific truth and acquire knowledge independently	To ensure the physical, intellectual, and moral development of a person
Approach to education	Logical, philosophical, theoretically grounded	Based on experiment and observation (empirical)	Comprehensive (theory + practice + psychology)
Source of knowledge	Reason, thought, logical analysis	Experiment, observation, scientific evidence	Experience, theory, and human development

Criterion	Abu Nasr al-Farabi	Abu Rayhan al-Biruni	Abu Ali ibn Sina
Teaching methods	Analysis, logical thinking, generalization	Observation, experiment, comparison	Practical training, observation, explanation
Approach to the student	Focused on intellectual development	Encourages independent inquiry	Applies an individual approach
Role of the teacher	Guide, encouraging thinking	Leader of scientific inquiry	Mentor, educator, psychologist
Education and society	Education—the foundation of an ideal society (“The Virtuous City”)	Education—a means of scientific progress and knowledge	Education—a factor in personal development and social progress
Moral education	Education of the perfect person is central	Scientific integrity and striving for truth	Moral purity and spiritual maturity are important
Practical significance	Theoretical and philosophical foundation	Scientific research methods	Application to medicine and real life
Connection with modern education	Competency-based approach, critical thinking	STEAM, scientific research methods	Differentiated education, interactive methods

Table 1.

The analysis of the three thinkers shows that their views on education and upbringing are complementary in nature, and they illuminate different aspects of a unified pedagogical system. In particular, Abu Nasr al-Farabi developed the theoretical and philosophical foundations of education and connected it with social development. Abu Rayhan al-Biruni interpreted education as a process of scientific inquiry and based it on methods of experiment and observation. Abu Ali ibn Sina considered education in harmony with the physical, intellectual, and moral development of a person.

By generalizing their views, it can be said that in the modern education system, these three directions—logical thinking (al-Farabi), knowledge based on scientific experimentation

(al-Biruni), and personal development (Ibn Sina)—must be applied in harmony with one another. It is precisely through this approach that it is possible to develop students' deep knowledge, independent thinking, and life competencies.

At the end of the nineteenth and beginning of the twentieth centuries, the education system in the territory of Turkestan was mainly based on traditional schools and madrasas. Education in these institutions was primarily oriented toward religious knowledge, with the main emphasis placed on reading the Qur'an, Arabic script, and memorizing religious texts. However, an important shortcoming of this system was that students' independent thinking, scientific reasoning, and acquisition of secular knowledge were not sufficiently developed. As a result, at a time when industrial and scientific-technological progress was accelerating, the development of society was significantly falling behind [9].

It was precisely under such historical circumstances that the Jadid movement emerged, aiming to fundamentally reform the education system. Jadidism was not merely a pedagogical reform but a broad enlightenment movement whose main idea was to awaken society through knowledge and education. Jadids viewed education as a major factor in social development and deeply understood the necessity of equipping the new generation with modern knowledge.

One of the leading representatives of the Jadid movement was Ismail Bey Gasprinsky, who developed and introduced the "Usul-i Jadid" (new method) education system. Gasprinsky put forward the idea that the awakening of all Turkic peoples could be achieved through educational reform. His famous slogan, "Unity in language, thought, and action," means that education is not only a means of providing knowledge but also an instrument of national unity and development [10].

Comparison of Jadid Methods and Modern Pedagogy

Criterion	Jadid educational methods	Modern pedagogy
Purpose of education	Increasing literacy, awakening society, educating an enlightened generation	Developing competencies, comprehensive development of the individual
Main approach	Understanding-based teaching ("Usul-i Jadid")	Competency-based and learner-centered approaches
Teaching method	Syllabic reading, explanation, question-and-answer	Interactive methods (PBL, case study, STEAM, problem-based learning)

Criterion	Jadid educational methods	Modern pedagogy
Role of the student	Active participant, thinking individual	Independent, creative, critically thinking subject
Role of the teacher	Guide, explainer	Facilitator, mentor, trainer
Educational content	Integration of religious and secular subjects	Interdisciplinary integration (STEAM), global knowledge
Use of visual aids	Maps, pictures, simple experiments	Multimedia, VR, simulations, laboratory activities
Practical orientation	Linking with everyday life	Real-life tasks, projects, and research
Individual approach	Partially present	Fully developed differentiated and individualized education
Assessment	Mainly oral and observation-based	Diagnostic, formative, and summative assessment
Outcome	Formation of a literate and enlightened society	A competent, innovative-thinking individual

Table 2.

Our analysis shows that the educational methods proposed by the Jadids were considerably ahead of their time, and many of their ideas are consistent with the principles of modern pedagogy. In particular, the Jadids' methods based on understanding-oriented education, activating students, practical orientation, and the use of visual aids can be regarded as the historical roots of today's interactive and competency-based approaches.

At the same time, modern pedagogy has further developed the ideas initiated by the Jadids and transformed them into a scientifically grounded system. For example, the simple use of visual aids present in Jadid education has now been enriched by digital technologies, while the individual approach has developed into a comprehensive pedagogical system.

Conclusion. The methodology of teaching biology is not limited to teaching biological knowledge but is an important pedagogical discipline that serves to comprehensively develop students, form their scientific thinking, and cultivate a conscious attitude toward nature. In this

respect, it serves as an important link between biology and pedagogy and is distinguished by its relevance in the modern education system.

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