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TECHNOLOGY OF MATHEMATICAL MODELING IN TEACHING NATURAL SCIENCES

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Abstract: This article highlights the theoretical foundations, didactic possibilities, and practical significance of using mathematical modeling technology in the process of teaching natural sciences. Through mathematical modeling, the development of students' logical thinking, analytical skills, problem-solving abilities, and interdisciplinary integration is scientifically substantiated. The article also presents examples of applying mathematical modeling technology in teaching biology, physics, and chemistry.

Key words: modeling, natural sciences, mathematical model, computer simulation, scientific research.

Аннотация: В данной статье рассматриваются теоретические основы, дидактические возможности и практическое значение использования технологии математического моделирования в процессе обучения естественным наукам. Посредством математического моделирования научно обоснованы вопросы формирования у обучающихся логического мышления, аналитических умений, навыков решения проблемных ситуаций, а также развития междисциплинарной интеграции. В статье также приведены примеры применения технологии математического моделирования при обучении биологии, физике и химии.

Ключевые слова: математическое моделирование, естественные науки, инновационные технологии, междисциплинарная интеграция, эффективность обучения.

Annotation: This article examines the theoretical foundations, didactic possibilities, and practical significance of using mathematical modeling technology in the teaching of natural sciences. Through mathematical modeling, the issues of developing students' logical thinking, analytical skills, problem-solving abilities, and interdisciplinary integration are scientifically substantiated. The article also presents examples of the application of mathematical modeling technology in teaching biology, physics, and chemistry.

Key words: mathematical modeling, natural sciences, innovative technology, interdisciplinary integration, educational effectiveness.

Main Text

In the modern education system, improving the teaching of natural sciences, forming students' scientific thinking, and integrating theoretical knowledge with practical activity are considered among the most pressing issues. In particular, ensuring interdisciplinary integration in teaching physics, chemistry, biology, and geography and introducing effective pedagogical technologies

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that help students deeply understand complex processes and phenomena play an important role in improving the quality and effectiveness of education.

Exact and natural sciences develop students' logical thinking, scientific research skills, and practical competencies. In teaching these subjects, the role of mathematics and information technologies is invaluable. Mathematical calculations and modeling methods, along with information technologies, make learning more effective and interactive. Students are provided not only with theoretical knowledge but also with opportunities to apply it in real-life situations.

Using computer programs and simulations such as Mathematica, MATLAB, and GeoGebra, teachers can provide deeper and more comprehensible knowledge. From this perspective, the article analyzes methods and software tools used in teaching exact and natural sciences through the integration of mathematics and information technologies.

In modern society, the rapid development of science and technology requires new approaches in education. Mathematics, based on precision and logic, serves as a strong foundation for other sciences. In physics, chemistry, biology, and astronomy, natural processes are studied quantitatively through mathematical formulas, equations, and modeling methods.

From this point of view, mathematical modeling technology is becoming an important methodological tool in teaching natural sciences. Through mathematical modeling, real objects, processes, and phenomena are described using equations, graphs, and algorithms, allowing deep analysis of their properties and laws. This helps develop students' logical thinking, analytical abilities, forecasting skills, and conclusion-making competence.

Mathematical modeling is one of the most effective tools for mastering natural sciences. It allows expressing the essence of real objects and phenomena in mathematical language and identifying their interrelations and development patterns. As a result, students' abstract thinking and analytical skills are enhanced.

Moreover, mathematical modeling ensures interdisciplinary integration between mathematics and natural sciences, forming a system of integrated scientific knowledge. When combined with computer technologies, the modeling process becomes even more effective, activating students' independent research and experimental activities.

This article provides a scientific and theoretical analysis of the pedagogical importance, methodological potential, and effectiveness of mathematical modeling technology in teaching natural sciences.

Literature Review

The issue of using mathematical modeling technology in teaching natural sciences has gained significant attention in recent pedagogical research. These studies focus on the didactic possibilities of modeling, its methodological foundations, and its influence on students' cognitive activity.

Foreign researchers such as J. Pollak, H. Blum, R. Lesh, and M. Doerr emphasize that modeling helps students express real-life situations mathematically, build models, test and improve them systematically.

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In CIS and local research, methodological aspects of modeling and its integration into subject content are widely discussed. Scholars such as V.P. Bespalko, N.F. Talizina, and L.S. Vygotsky highlight the importance of activity-oriented and developmental education concepts closely linked with modeling.

Mathematical modeling is the process of studying and analyzing real-life processes and phenomena using mathematical language (formulas, equations, graphs, algorithms, tables). Its importance lies in understanding complex processes, making predictions, serving as a basis for science and technology development, and enhancing logical and analytical thinking in education.

Didactic Possibilities of Mathematical Modeling

Mathematical modeling in natural sciences:

strengthens interdisciplinary integration;

enables visualization of abstract concepts;

supports problem-based learning;

increases students' cognitive activity;

directs knowledge toward practical application.

For example, population dynamics in biology can be analyzed using differential equations, physical and thermodynamic processes in physics can be modeled mathematically, and chemical reaction kinetics can be simulated.

Pedagogical Effectiveness

Educational experience shows that lessons using mathematical modeling significantly improve learning outcomes. This technology:

develops critical and analytical thinking;

forms scientific problem-solving skills;

links theory with real-life situations;

ensures interactive learning.

When integrated with information and communication technologies, the innovative character of education becomes even stronger.

Importance of Modeling in Natural Sciences

Modeling in Physics:

Modeling is one of the main research methods in physics. Motion is described using differential equations, and complex systems are studied through computer simulations.

Modeling in Chemistry:

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Chemical modeling is widely used to study reaction mechanisms, molecular structures, and reaction rates. Molecular modeling allows predicting properties of new substances.

Modeling in Biology:

Biological systems such as populations, ecosystems, and cellular processes are studied using models. Epidemiological models help analyze disease spread.

Modeling in Earth Sciences:

Modeling is used in geophysics, meteorology, and ecology to study climate change and natural disasters.

Conclusion

Mathematical modeling is an integral part of scientific cognition. It allows simplified study of complex natural processes, identification of fundamental laws, and prediction of future states. Modeling links theory and experiment, increasing the effectiveness of scientific research.

In conclusion, mathematical modeling technology is an innovative pedagogical tool with high scientific and methodological effectiveness in teaching natural sciences. It forms students' scientific thinking, systematic reasoning, and competency-based learning skills. Therefore, the systematic implementation of mathematical modeling in natural science education is one of the strategic objectives of modern education.

References

1.Azizkho‘jayeva N.N. Pedagogical Technologies and Teaching Mastery. – Tashkent.

2.Qodirov A., Khudoyberganov R. Methods of Teaching Natural Sciences. – Tashkent.

3.Polat E.S. Modern Educational Technologies. – Moscow.

4.Lesh R., Doerr H. Beyond Constructivism: Models and Modeling Perspectives on Mathematics Problem Solving.

5.Hestenes D. Modeling Methodology for Physics Teachers.

6.Samarskiy A.A. Mathematical Modeling. — Moscow: Nauka, 2005.

7.Murray J.D. Mathematical Biology. — Springer, 2002.

8.Haken H. Synergetics. — Springer-Verlag, 1983.

9.Trenberth K.E. Climate System Modeling. — Cambridge University Press, 1992.