Published Date: - 31-01-2026
Page No: - 63-67

PROBLEMS AND SOLUTIONS IN INTEGRATING ARTIFICIAL INTELLIGENCE INTO THE BIOLOGY TEACHING PROCESS

Pulatova Elnora Kodirovna
Astrakhan State Technical University, Tashkent Region Branch, Uzbekistan

ABSTRACT

The article analyzes the main problems and solutions related to the integration of artificial intelligence in the biology teaching process. Special attention is given to the use of AI tools to improve the educational process and enhance students' competencies. The paper also examines technical and pedagogical barriers to implementation and proposes effective solutions.

KEYWORDS: Artificial intelligence, biology education, teaching process, problems, solutions, pedagogy, technology.

INTRODUCTION

Nowadays, the field of education is rapidly developing, and artificial intelligence (AI) technologies play an important role in this process. The use of artificial intelligence in teaching biology allows the learning process to become more interactive and effective. At the same time, the implementation of AI technologies brings various challenges. This article analyzes the main problems of applying artificial intelligence in biology education and the solutions to these challenges.

AI and Its Significance in Education. Artificial intelligence (AI) is the simulation of certain human mental functions, including data processing, decision-making, and problem-solving, using computers or software. In the field of education, AI technologies are applied to automate the learning process, create individualized learning paths, and assess students' knowledge levels [1]. Due to the nature of biology, which includes a large amount of visual and practical material, AI-based interactive programs, simulations, and training tools help students reinforce their theoretical knowledge through practical application.

The Significance of AI-Based Interactive Programs, Simulations, and Trainers in Biology.

Understanding the Structure and Functions of Cells and Tissues: Through virtual microscope simulators, students can visually explore cell structures and the functions of various organelles. This approach helps in comprehending theoretical knowledge from a practical perspective.

Modeling Cell Division (Mitosis and Meiosis): Using mitosis and meiosis simulators, students can observe these processes step by step and identify their differences. Understanding these processes becomes easier and deeper compared to studying them only through texts or diagrams.

Organism Biology and Ecology: Ecosystem simulators allow students to study interactions between different organisms, food chains, and environmental impacts. These simulations provide an opportunity to test the theoretical aspects of biology and ecology in practice.

DNA and Genetics: Studying DNA synthesis and genetic mutations through interactive models helps students understand how the genetic code works. By simulating genetic problems (e.g., hereditary diseases), students learn to identify issues and find solutions.

Experiments and Practical Work: Many biology experiments can be conducted safely and conveniently through simulators. For example, certain experiments that are time-consuming or require specialized equipment can be performed in a virtual environment.

Thus, AI-based interactive programs, simulations, and trainers in biology help students test their theoretical knowledge in practice, deepen their understanding, and make learning biology more engaging. They provide opportunities to reinforce knowledge and conduct independent experiments [2].

Popular Biology Simulations and Interactive Programs

PhET Interactive Simulations (University of Colorado Boulder). Website: phet.colorado.edu. Several simulations related to biology are available, including cell structure, genetics, ecosystems, and other topics. They provide students with clear and visual opportunities for hands-on experience.

CellCraft. Website: cellcraftgame.com. This is a game-based interactive simulation where students learn about the various functions of cells. It allows understanding of cell structure, energy metabolism, and genetic processes through gameplay.

BioDigital Human. Website: biosdigital.com. This is a 3D interactive model of the human body that helps study various systems and organs. It is designed for deep and visual understanding of human anatomy.

Learn.Genetics (University of Utah). Website: learn.genetics.utah.edu. Offers interactive lessons, simulations, and video materials on various genetics and biology topics. It is a free and high-quality educational resource.

Bioman Biology. Website: biomanbio.com. A collection of games and simulations covering various areas of biology. It facilitates understanding and makes the learning process more engaging.

Additional Recommendations: Most of these simulations are in English; however, due to their visual and interactive nature, students can overcome the language barrier easily. It is recommended to complement them with additional videos and multimedia materials for enhanced learning.

Challenges in Implementing AI in Biology Education

Technical Challenges

Insufficient Infrastructure: Many schools lack the necessary computer equipment and reliable internet access.

High Cost of AI Programs: Quality AI programs are often expensive, requiring significant financial resources for purchase and implementation.

Limited Technical Support: The introduction of AI tools is hindered by a shortage of qualified technical specialists.

Pedagogical Challenges

Teachers' Unpreparedness to Use AI: Educators may have low readiness to learn and apply new AI technologies.

Need to Restructure the Learning Process: Lessons need to be redesigned to align with AI tools.

Mismatch Between Programs and Curriculum: Existing programs may not fully cover all topics in biology, limiting their effectiveness.

Solutions for Implementing AI in Biology Education

Technical Solutions

Improving Infrastructure: Schools should prioritize providing high-quality computers and fast internet access. Projects can be implemented through cooperation between government and private sectors.

Selection and Licensing of Programs: Choosing AI tools that are effective and aligned with local educational requirements, and licensing them, can help reduce costs.

Training and Skill Development for Technical Specialists: Educational institutions should organize special courses to train technical staff and continually enhance their skills.

Pedagogical Solutions

Training Teachers in AI Technologies: Special seminars, workshops, and professional development courses should be organized for teachers to develop their skills in effectively using new AI technologies.

Modernizing the Curriculum: The biology curriculum should be reviewed and updated to align with AI tools. This will create opportunities for the broader integration of new technologies into the teaching process.

Creating Interactive Learning Materials: It is important to develop AI-based visual and practice-oriented materials, simulations, and tests, and to actively use them in lessons [3].

Practical Examples of AI Tools in Biology Education

Nowadays, a number of AI-based platforms and programs are being used in biology education worldwide. They serve to make the learning process more interactive and visually engaging. For example:

Virtual Laboratories: These programs allow students to conduct various biological experiments in a virtual environment, either at home or on school computers. Topics studied in these laboratories include the structure of different organisms, enzyme activity, genetics experiments, and many other subjects.

Interactive Simulations: AI-powered models have been developed for subjects such as genetics, ecology, and physiology. These simulations allow complex biological processes to be presented in a simplified and understandable manner.

Testing and Assessment Systems: AI technologies enable the identification of individual students' knowledge levels and gaps. This allows teachers to manage the learning process more effectively.

Future Prospects

The implementation of AI in biology education offers the potential to fundamentally transform the field of education in the future. For example:

Personalized Learning: Educational programs can be designed to match the abilities and interests of each individual student.

Robotic Teachers and Assistants: AI-powered robots or virtual assistants can provide individualized support to students.

Development of Practical Skills: AI tools can be widely used to solve real-life problems in the field of biology [4]. This includes:

Modeling Real-Life Problems: Through simulations, students are presented with authentic challenges in ecology, biotechnology, genetics, or medicine. For instance, the effects of

ecosystem imbalances or genetic mutations can be simulated, allowing students to analyze consequences and make informed decisions.

Problem-Solving Skills: In complex biological situations (e.g., diagnosing diseases or controlling the spread of infections), simulators can help students practice making quick and accurate decisions. This allows theoretical knowledge gained in textbooks or classrooms to be applied in practice.

Understanding Multifactorial Analysis and Complex Interconnections: Simulations consider numerous variables, such as environmental factors, internal processes of organisms, and genetic factors. Students develop the skills to analyze such complex systems and understand the relationships between them.

Collaboration and Communication

Many interactive programs and simulators require group work, which helps develop skills in collaborative decision-making and exchanging ideas. Teamwork is essential in solving problems in biology. Specifically:

Integration of Specializations: Biology is a broad field, encompassing areas such as molecular biology, ecology, genetics, biotechnology, and medicine. Experts in each area possess different knowledge and skills. To solve problems effectively, their expertise and perspectives need to be combined.

Creativity and Diverse Perspectives: Teams with varied ideas and approaches encourage students to generate new concepts and solutions. This is crucial for addressing complex biological problems, such as treating diseases or maintaining ecological balance.

Comprehensive Problem Analysis: Biological problems often require multifaceted analysis and complex solutions. Team members examine issues within their areas of expertise, contributing to the development of overall solutions.

Coordination and Efficiency: Teamwork teaches students to allocate tasks, develop effective work plans, and execute them efficiently. This helps save time and resources when conducting complex biological experiments or research.

Communication Skills: Clear and effective expression of ideas and exchanging viewpoints with others are vital in solving biological problems. Collaborative work helps students improve their communication abilities.

Positive Impact on Society: Many issues in biology affect society and the environment. Collaborative learning and teamwork increase opportunities to approach these problems from a global perspective and find effective solutions.

Thus, teamwork is critically important in solving problems in the field of biology. It integrates knowledge from various specializations, encourages the search for creative solutions, allows for comprehensive problem analysis, and helps develop students' communication and leadership skills. This, in turn, ensures higher efficiency in scientific research and practical work.

Understanding Responsibility and Social Significance

Through practical simulations, students study environmental issues, genetic ethics, and human health, gaining insight into their societal impact. This enhances their sense of responsibility.

Thus, AI-based interactive simulations and trainers are crucial in biology education not only for reinforcing theoretical knowledge but also for developing practical skills necessary to solve real-world problems. They prepare students to make quick and informed decisions in complex

situations, teach them to analyze problems from multiple perspectives, and develop teamwork skills.

Recommendations and Suggestions

Strengthening Collaboration Between Educational Institutions and Government Agencies: Enhance cooperation to implement AI in education.

Continuous Professional Development for Teachers: Organize ongoing training courses to improve teachers' skills in using AI technologies.

Improving Infrastructure and Securing Financial Resources: Allocate funds for technological implementation and the development of educational infrastructure.

Developing and Applying AI Tools Suitable for Local Needs and Contexts:

Considering Local Context and Culture: AI tools should align with local languages, culture, traditions, and educational systems. For example, AI programs used in education should be developed in the Uzbek language and comply with local educational standards.

Accounting for Economic and Technical Capabilities: Local conditions, such as internet speed, device availability, and access to resources, vary. Therefore, AI tools should be lightweight, resource-efficient, and able to function offline to ensure wider adoption and usability.

Solutions Targeted at Local Problems: AI tools should address specific local issues, such as in agriculture, education, medicine, or ecology, to provide effective solutions to real-life challenges.

Integration of Regional Data and Knowledge: Local data, statistics, and expert knowledge are essential for AI models adapted to local conditions, increasing accuracy and effectiveness.

Adaptation to Education and Labor Market Needs: AI tools that align with local education systems and workforce requirements effectively develop students' and specialists' skills. For example, simulators and training programs designed for local industrial or agricultural sectors.

Compliance with Social and Ethical Standards: AI tools must respect human rights, privacy, and ethical norms and consider local social values.

User Support and Training: Providing manuals and training for local specialists and users ensures the correct and effective use of AI tools.

REFERENCES

1. Ahmedov, Sh.M. Application of Artificial Intelligence in Education. Tashkent: Ilmiy Nashrlar, 2022.
2. Ivanov, A.V. Artificial Intelligence in Education: Opportunities and Challenges. Moscow: Education of the 21st Century, 2021.
3. Smith, J. Artificial Intelligence in Biology Education: Trends and Perspectives. Journal of Educational Technology, 45(2), 112–130, 2023.
4. UNESCO. Artificial Intelligence in Education: Challenges and Opportunities. [Online] Available at: https://unesdoc.unesco.org/ark:-/48223/-pf0000370707, 2020.