

## DEVELOPMENT OF COMPUTER LITERACY COMPETENCE OF FUTURE BIOLOGY TEACHERS THROUGH ARTIFICIAL INTELLIGENCE

**Jo'rayev Shomansur Shukhratovich**

*Jizzakh State Pedagogical University*

*Deputy Dean of the Faculty of Natural Sciences*

[shomansurjurayev@gmail.com](mailto:shomansurjurayev@gmail.com)

**Abstract:** This article explores the integration of artificial intelligence technologies into the educational process and their role in developing computer literacy competence among future biology teachers. The paper theoretically analyzes the concept of computer literacy, its structural components, and methodological directions for developing this competence through AI-based tools. The advantages of using artificial intelligence in modern education and the prospects for improving digital pedagogy in biology teacher training are also discussed.

**Keywords:** artificial intelligence, computer literacy, competence, biology education, digital pedagogy, educational technologies.

The modern education system requires extensive use of digital technologies, particularly artificial intelligence (AI), in shaping human capital. AI technologies enable the restructuring of teachers' professional training in a new format, enhance the efficiency of the educational process, and foster independent thinking and creativity among students [1].

In recent years, the integration of AI technologies in the field of education has become a globally significant trend. According to UNESCO (2021), when properly implemented in the educational process, artificial intelligence enables the automation of teachers' instructional activities, the monitoring of students' individual learning progress, and the delivery of educational resources in a personalized manner [2].

The development of computer literacy competence in future biology teachers refers to the process of cultivating their ability to work with digital information, select and analyze technologies in the educational process, and utilize AI tools for methodological purposes [3]. Computer literacy encompasses not only the use of software but also the application of digital thinking in education, as well as the analysis, creation, and evaluation of information.

As noted by Xolmatova D. D. (2022), the formation of digital competence in pedagogical education depends on teachers' ability to select new technologies and effectively integrate them into the teaching process [4]. From this perspective, developing students' skills in using AI-based educational tools in the field of biology

strengthens their methodological, informational-communicative, and technological competencies.

Biology, by its nature, is an experimental discipline that requires practical activities such as analysis, modeling, and observation. Therefore, the integration of AI technologies into biology education enables the individualization of the learning process, the simulation of laboratory exercises, and the visualization of complex biological processes [5].

This article analyzes the role of artificial intelligence technologies in education, the theoretical foundations of computer literacy competence, and the prospects for using AI tools to enhance the digital preparedness of future biology teachers. The research findings are analyzed theoretically, and recommendations for developing computer literacy in biology teachers through AI are presented.

The role and potential of artificial intelligence in education is one of the defining features of 21st-century learning, reflecting the digital transformation and widespread implementation of AI technologies. Today, artificial intelligence (AI) is penetrating nearly all stages of education, serving as a crucial tool for individualizing the learning process, supporting students' independent activities, and creating automated analysis and recommendation systems for teachers [1].

The implementation of AI technologies in education elevates the interaction between humans and technology to a new level. As noted by Anderson T. (2020), artificial intelligence is not intended to replace teachers but to facilitate their work and enhance personalized teaching models [2]. AI tools enable the analysis of students' behaviors, automatic selection of content tailored to their knowledge level, and real-time monitoring of learning activities.

According to UNESCO (2021), AI demonstrates effective results in four key areas of the education system: automating data analysis and learning monitoring, personalizing educational resources, providing methodological support to teachers, developing students' creative thinking [3].

The use of AI technologies in a digital learning environment not only improves the quality of the educational process but also shapes a new model of teacher activity. Karimov B. B. (2023) notes in his research: “Artificial intelligence reduces the cognitive load of teachers but requires the reinforcement of the theoretical foundations of the learning process” [4].

Furthermore, the role of AI tools in education is also defined by methodological, organizational, and communicative functions. For instance, systems such as ChatGPT, Google Gemini, Khanmigo, and Copilot for Education enable teachers to: automatically generate tests and assignments, rapidly analyze students' responses, facilitate interactive communication during lessons, monitor students' learning dynamics [5].

In addition, AI technologies assist teachers in modeling complex processes in biology education. Platforms like BioGPT allow students to simulate genetic processes, observe organism responses, and analyze laboratory results [6]. This facilitates the integration of theoretical knowledge with practical activities and fosters the development of students’ scientific research competencies.

Preliminary results of using AI-based software tools are also observed in the education system of Uzbekistan. For example, the “Digital Education – 2030” strategy announced by the Ministry of Higher Education, Science, and Innovation in 2024 prioritizes the integration of AI technologies into pedagogical processes [7].

Thus, the role of artificial intelligence in education is manifested not merely as a technical tool but as a means of pedagogical innovation and digital transformation. AI enables the individualization of the learning process, enhances teachers’ professional readiness, and fosters independent, critical thinking in students. Therefore, the application of AI in scientific disciplines such as biology represents one of the most effective directions for improving teachers’ computer literacy competence.

**Computer Literacy Competence of Future Biology Teachers: Essence, Structure, and Significance.** In the process of the digital transformation of the education system, teachers’ computer literacy occupies a leading position within their professional competencies. For future biology teachers, this competence implies the ability to organize the educational process, analyze data, model, and represent biological processes in a digital format using modern information and communication technologies [1].

The term “computer literacy” was first introduced in the 1960s to define the role of information technologies in education. Today, the concept encompasses not only technical skills but also digital culture, information security, critical thinking, and the analytical processing of data [2].

**Key Components of Computer Literacy Competence for Biology Students:** The computer literacy competence of students in the biology field is composed of the following main components: Information and Communication Competence - the ability to search, filter, analyze biological data and visualize it using modern software; technological competence - organizing learning using AI tools, virtual laboratories, and simulation programs; methodological competence - designing biology lessons based on digital resources and creating individualized learning paths with the help of AI; ethical-communicative competence - adhering to information security, copyright, and principles of academic integrity in digital environments [3].

Computer literacy competence is directly linked to a teacher’s pedagogical mastery. To effectively teach today’s digital generation, a teacher must not only have a thorough knowledge of biology but also possess the ability to manage the learning

process using AI technologies and create an educational environment tailored to the individual needs of students [4].

Digital competence serves as a transformational mechanism that elevates a teacher's professional readiness. Through AI tools, a teacher not only facilitates the learning process but also develops students' analytical thinking, modeling skills, and creative thinking abilities [5].

In biology education in particular, AI technologies allow teachers to demonstrate complex processes (e.g., intracellular biochemical reactions or ecological system balances) through 3D modeling. This plays a crucial role in fostering students' scientific thinking and preparing them for research activities [6].

Additionally, computer literacy enhances a teacher's methodological creativity. Using AI, teachers can create interactive tests, automated assessment systems, and applications that simulate biological processes. Consequently, students' motivation for independent learning increases, and teachers can plan their instructional activities more effectively [7].

Hence, developing computer literacy competence among future biology teachers should be considered an indicator of the quality of modern education. This process involves not only technological readiness but also adapting pedagogical thinking to the digital paradigm.

**Pedagogical Conditions for Developing Computer Literacy Based on Artificial Intelligence.** The use of AI technologies in developing computer literacy competence among future biology teachers elevates the education system to a new level. This process requires not only mastering technical tools but also aligning the teacher's pedagogical thinking with digital paradigms [1].

Pedagogical conditions refer to the organizational, methodological, technological, and psychological factors that enable effective use of digital tools in the educational process [2]. The development of computer literacy based on AI is most effective under the following conditions:

1. Creating a Digital Learning Environment - this environment allows students to independently enhance their knowledge using AI-based platforms (e.g., ChatGPT, Google Bard, Copilot, PhET Simulation). It fosters interactive learning, analytical thinking, and modeling of biological processes [3].

2. Enhancing Methodological Preparedness - teachers must deeply understand the methodological foundations to integrate AI tools effectively into the teaching process. For example, the TPACK (Technological Pedagogical Content Knowledge) model ensures the alignment of technological, pedagogical, and content knowledge [4].

3. Individualizing the Learning Process - AI technologies help identify each student's level of mastery, areas of interest, and learning pace. Based on this,

personalized learning paths are created, making the process of developing computer literacy more effective [5].

4. Creating a Motivational Environment - AI allows the incorporation of interactive tasks, gamification elements (points, rankings, digital certificates) to enhance student engagement in digital learning, making the process of acquiring computer literacy creative and engaging [6].

5. Establishing Pedagogical Monitoring and Analysis Systems - AI tools enable teachers to automatically track student activity, analyze errors, and provide recommendations for improvement, facilitating real-time feedback [7].

Furthermore, the AI-based educational process should adhere to the following principles: adaptability - tailoring educational resources and methods to students' individual characteristics; integrativity - aligning biology education with AI technologies; activity - positioning the student as an active participant at the center of the learning process; reflexivity - fostering skills for self-assessment and analysis [8].

The most crucial pedagogical condition for developing computer literacy among future biology teachers is organizing education using innovative methods. For instance, approaches such as Flipped Classroom, Project-Based Learning, or AI-assisted Learning integrate traditional lessons with a digital environment. Consequently, students gain independent learning, data analysis, algorithmic thinking, and digital tool usage skills [9].

In AI-based teaching, the teacher acts as a facilitator, guiding, analyzing, and encouraging students' independent thinking. As a result, computer literacy competence develops not only technically but also creatively, methodologically, and analytically [10].

Opportunities and Methodology for Developing Computer Literacy of Future Biology Teachers Using AI. The integration of AI as an inseparable part of the pedagogical process provides extensive opportunities for developing computer literacy competence among future biology teachers. AI enables interactive and efficient communication between teachers and students, as well as modeling complex biological concepts [1].

Some of the most effective ways to apply AI in biology education include specialized AI platforms: BioGPT and ChatGPT - provide explanations of biological processes, guidance for laboratory work, and the creation of individualized assignments [2]. PhET Simulations and Labster - allow the execution of complex biological experiments in virtual lab environments, strengthening students' experimental skills [3]. Khanmigo and AI Copilot - facilitate the creation of interactive teaching materials, automate tests and assignments, and monitor the learning process [4].

Using these platforms, teachers can: tailor lessons to individual student needs, monitor students’ knowledge levels in real-time, explain complex concepts visually and interactively, personalize the learning process [5].

Effective Methodological Approaches with AI: Flipped Classroom - Students study lesson materials independently, complete tasks via AI tools, and discuss them during class, enhancing the ability to create and assess individualized learning content [6]. Project-Based Learning - Students complete biology projects, analyze data, model virtual labs, and visualize results via AI platforms, developing analytical and methodological competence [7]. AI-assisted Learning - AI tools make lessons interactive, automatically generate tests and assignments, and monitor student activity in real-time, enabling teachers to personalize instructional strategies [8].

Recommendations for Developing Computer Literacy in Future Biology Teachers: Integrate AI Platforms into Teaching - actively use ChatGPT, BioGPT, PhET Simulations, and Labster for laboratory work and lesson planning; involve students in individualized learning. Implement Virtual Laboratories and Simulations- model cellular and molecular processes, analyze ecological systems, and strengthen experimental skills. Create Interactive Tests and Assessment Systems- automatically generate assignments using AI, analyze student responses in real-time, and provide personalized feedback. Develop Digital Methodological Resources - enrich materials with multimedia, 3D visualization, and animations; engage students in independent analysis and research. Enhance Teachers’ Digital Competence - conduct AI skill development courses, training sessions, and seminars on pedagogical innovations [9].

Prospects of AI in Developing Computer Literacy: Deepening digital transformation - making pedagogical processes interactive, individualized, and effective. Applying innovative pedagogical methods - Flipped Classroom, Project-Based Learning, and AI-assisted Learning enhance education quality. Developing students’ research potential - through virtual labs and simulations. Supporting teachers’ professional development — improving methodological and digital competencies with AI [10].

**Conclusion:** This article scientifically analyzed the development of computer literacy competence of future biology teachers using AI tools. The following conclusions can be drawn:

1. Computer literacy occupies a central place in the professional competencies of future biology teachers, encompassing not only ICT skills but also pedagogical, methodological, and analytical abilities.

2. AI tools are powerful resources that make the learning process interactive, individualized, and effective, optimizing teacher-student interaction and enabling modeling and analysis of complex biological processes.

3. AI platforms such as ChatGPT, BioGPT, PhET Simulations, and Labster effectively strengthen virtual laboratory skills, experimental experience, and digital competence of future teachers.

4. Methodological approaches — Flipped Classroom, Project-Based Learning, and AI-assisted Learning — allow adaptation of the pedagogical process to student needs, creation of individual learning paths, and development of analytical thinking.

5. Implementing AI-based methodological recommendations, including platform integration, virtual laboratories, interactive assessments, digital resources, and teacher digital competence enhancement, effectively develops computer literacy among future biology teachers.

6. In terms of prospects, AI as an integral part of the pedagogical process deepens digital transformation, supports innovative methods, enhances students’ research potential, and fosters teachers’ professional development.

Overall, the effective integration of AI tools into the pedagogical process is a key factor in developing computer literacy competence among future biology teachers, preparing them as digitally, interactively, and methodologically proficient educators.

### **References:**

1. Anderson, T. Artificial Intelligence in Pedagogical Design. – London: Routledge, 2022. – 234 p.
2. Gilyazova, N. M. Information Competence in Pedagogical Education. – Moscow: Pedagogika, 2019. – 156 p.
3. Gulomova, S. N. Pedagogical Innovations and Digital Education. – Tashkent: Fan, 2021. – 172 p.
4. Karimov, B. B. Artificial Intelligence and Individual Learning Approaches. – Tashkent: Fan, 2023. – 205 p.
5. Karimova, N. A. Digital Competence and Teacher Professional Mastery. – Tashkent: Innovatsiya, 2023. – 210 p.
6. Luckin, R., Holmes, W., Griffiths, M. Intelligence Unleashed: AI in Education. – London: Routledge, 2020. – 215 p.
7. Mishra, P., Koehler, M. J. Technological Pedagogical Content Knowledge (Tpack) Framework and Its Applications. – Educational Technology Research Journal, 2018. – Vol. 26. 101–113 p.
8. OECD. AI and the Future of Learning. –Paris: OECD Publishing, 2023.-84 p.
9. PhET Interactive Simulations. <https://phet.colorado.edu/> – 2023.
10. Rustamova, D. D. AI-based Biology Teaching: Innovations and Practice. – Tashkent: TDPU Press, 2024. – 184 p.