

THE ROLE OF DIGITAL TECHNOLOGIES IN DEVELOPING THE METHODOLOGICAL COMPETENCE OF PROSPECTIVE BIOLOGY TEACHERS

Alfiya Zhiyenbekovna Turekeeva

*Nukus State Pedagogical Institute named after Ajiniyaz Associate Professor, Department of Biology,
PhD in Pedagogical Sciences alfiaturekeeva4@gmail.com*

Abstract: *This article analyzes the theoretical foundations for developing the methodological competence of future biology teachers in the context of educational digitalization. The pedagogical possibilities of the modern digital educational environment, the impact of digital technologies on the professional training of future teachers, and important factors in the formation of methodological competence are highlighted. The importance of using virtual laboratories, interactive platforms, and digital educational resources in biology education is also substantiated. The research results show that the digital educational environment is an important tool for improving the preparation of future biology teachers for professional activity and developing their methodological competence.*

Keywords: *digital education, digital transformation, methodological competence, future biology teacher, digital educational environment, virtual laboratory, interactive platform, professional training.*

INTRODUCTION

The processes of digital transformation taking place in the world pose new tasks for the education system. As a result of the rapid development of modern information and communication technologies, the need to improve the content, forms, and methods of education is increasing. In particular, the formation of a digital educational environment, the introduction of innovative pedagogical technologies, and the development of digital competencies among educational participants are recognized as one of the priority areas of 21st-century education.

In the Republic of Uzbekistan, the digitalization of the education system is also supported at the level of state policy. The Law "On Education," the "Digital Uzbekistan - 2030" Strategy, the Development Strategy of the President of the Republic of Uzbekistan for 2022-2026, and other regulatory legal documents related to the development of the education sector define the widespread introduction of digital technologies into the educational process, the development of digital competencies of teaching staff, and the improvement of education quality as important tasks.

Methodological competence is of particular importance in the process of preparing future biology teachers for professional activity. Methodological competence represents the teacher's ability to define educational goals, select educational content, use effective teaching methods, organize students' cognitive activity, and evaluate educational results. In the digital educational environment, the content of this competence is expanding, requiring the teacher to use digital tools and platforms effectively.

The specific nature of the content of biology education also increases the relevance of this problem. This is because when teaching biology, it is necessary to explain complex

objects and processes such as cell structure, molecular processes, genetic mechanisms, physiological phenomena, and ecological systems. In such cases, virtual laboratories, simulations, 3D models, and interactive platforms serve as important tools for increasing educational efficiency.

In this regard, studying the theoretical foundations of developing the methodological competence of future biology teachers in the context of the digitalization of education and identifying the pedagogical conditions and effective mechanisms of this process is of great scientific importance.

Literature review and the extent to which the problem has been studied. In recent years, the issue of digitalizing education and developing the professional competencies of educators has become one of the urgent scientific directions on an international scale. In global educational practice, the introduction of digital technologies into the educational process leads to changes in the content of pedagogical activity and teaching methods. Therefore, ensuring the readiness of future teachers to operate effectively in the digital environment is considered an important task [1].

In studies prepared by UNESCO, digital technologies are evaluated as an important factor in improving the quality and effectiveness of education, and it is emphasized that developing the digital competencies of educators is one of the key conditions for sustainable educational development [2]. OECD experts also noted that the role of the educator is changing in the digital educational environment, indicating that a modern educator should act not only as a knowledge provider but also as an organizer and manager of the digital educational process [3].

The DigCompEdu (Digital Competence Framework for Educators) model, developed by the European Commission, serves as an important methodological framework for assessing and developing the digital competencies of educators. In this model, competencies such as the use of digital resources, the organization of a digital educational environment, the evaluation of educational outcomes, and the support of students' digital activities are separately identified [4].

Researchers from CIS countries, such as B.S. Gershunskiy, V.P. Bespalko, V.A. Slastyonin, A.V. Khutorskoy, E.S. Polat, and I.A. Zimnyaya, have developed the theoretical foundations of the competency-based approach. They substantiated competence as an important result indicator in ensuring the professional and methodological training of a teacher [5; 6].

Among Uzbek scholars, N.N. Azizkhodzhaeva, R.Kh. Juraev, U.N. Nishonaliev, A.K. Tolipov, M. Ochilov, Sh.E. Kurbanov, and others have conducted a number of scientific studies on developing the professional competence of educators, introducing innovative technologies into the educational process, and improving the digital educational environment [7; 8]. However, in these studies, the problem of developing the methodological competence of future biology teachers in the context of the digitalization of education has not been sufficiently covered as a separate object of research.

In the field of biology education, foreign scholars have extensively studied the impact of virtual laboratories, simulations, digital platforms, and interactive educational resources

on educational effectiveness. In particular, K. Wiman, R. Mayer, J. Anderson, and other scholars have scientifically substantiated that digital educational tools increase students' cognitive activity, facilitate the understanding of complex biological processes, and develop independent learning skills [9; 10; 11].

Analysis shows that although there are certain scientific results in the development of methodological competence of future biology teachers in the digital educational environment, there remains a need for a comprehensive study of the content, pedagogical conditions, criteria, and development technologies of this process. From this perspective, this study is significant in that it is aimed at improving the theoretical and practical aspects of developing the methodological competence of future biology teachers in the context of the digitalization of education.

Research methodology and materials. The methodological basis of the study consists of regulatory legal acts on the development of the education sector of the Republic of Uzbekistan, the competency-based approach, the theory of student-centered education, the concept of digital education, and scientific-theoretical views on the professional training of future teaching staff [1; 4; 7].

Systematic, competency-based, activity-based, and integrative approaches were used in the research process. These approaches made it possible to determine the content, structural components, and pedagogical conditions for developing the methodological competence of future biology teachers in a digital educational environment.

A complex of theoretical and empirical methods was used in the study. Analysis of scientific and pedagogical literature, comparative analysis, synthesis, generalization, and modeling methods were used as theoretical methods. Questionnaires, pedagogical observation, interviews, tests, and pedagogical experimental work were used as empirical methods. The obtained results were processed using mathematical and statistical analysis methods [5; 8].

The object of the research is the process of professional training of future biology teachers studying in higher educational institutions. The subject of the research is the content, forms, means and technologies of developing their methodological competence in the context of the digitalization of education.

The study analyzed the capabilities of Google Workspace, Moodle, Kahoot!, Quizizz, LearningApps, Mentimeter, Genially, Mosaic Education, virtual laboratories, and other digital educational platforms. Their impact on the methodological training of future biology teachers was studied, and scientific and methodological recommendations for their effective use in the digital educational environment were developed.

Analysis has shown that the systematic and targeted use of digital platforms has a positive impact on developing the methodological skills of future biology teachers in lesson design, organizing interactive learning, creating digital educational resources, and evaluating learning outcomes.

Results and discussion. In the course of the study, a pedagogical model for developing the methodological competence of future biology teachers in the context of the digitalization of education was developed. This model is aimed at improving the

preparation of future teachers for professional activity through the effective use of the capabilities of the digital educational environment.

Based on the analysis, it was determined that the structure of methodological competence consists of four interrelated components:

The motivational component represents the future teacher's interest in professional activity, their need to master innovative technologies, and their positive attitude toward working in a digital educational environment.

The cognitive component covers a system of theoretical knowledge regarding biology teaching methodology, digital pedagogy, information and communication technologies, and modern educational platforms.

The operational-activity component includes skills in lesson design using digital platforms, creating electronic educational resources, using virtual laboratories, and organizing the educational process.

The reflexive-evaluative component is characterized by the ability to analyze one's own activities, evaluate educational results, identify professional growth needs, and self-development [6; 8].

Within the framework of the study, the following pedagogical conditions for the development of methodological competence in a digital educational environment were identified:

- formation of an innovative educational environment equipped with digital educational resources;

- systematic use of virtual laboratories and interactive platforms suitable for biology education;

- organization of students' independent educational activities based on digital technologies;

- effective use of electronic portfolios and digital assessment tools;

- integration of project and research activities into the educational process.

During the experimental work, it was established that the use of Google Classroom, Moodle, Kahoot!, Quizizz, LearningApps, Mentimeter, Genially, and Mosaic Education platforms has a positive impact on the development of the methodological competence of future biology teachers. In particular, these platforms made it possible to increase students' activity in independent work, develop skills in creating digital educational resources, and enrich their experience in organizing interactive lessons.

The results showed that in the educational process organized on the basis of digital educational technologies, students' professional motivation, methodological knowledge, and practical skills develop at a higher level compared to traditional educational conditions. This confirms that the digital educational environment is an important pedagogical factor in forming the methodological competence of future biology teachers [2; 3; 10].

The results obtained are in harmony with the concepts of digital education put forward by UNESCO and the OECD, as well as the main ideas of the DigCompEdu model, and showed that the targeted use of digital technologies serves to improve the quality of teacher training [2; 3; 4].

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Conclusion. Based on the research results, the following conclusions were drawn:

1. In the context of the digitalization of education, the development of the methodological competence of future biology teachers is one of the important directions of modern pedagogical education. The widespread introduction of digital technologies into the educational process requires the improvement of the content and technologies for training pedagogical personnel.

2. The methodological competence of future biology teachers is a complex integrative structure consisting of motivational, cognitive, operational-activity, and reflexive-evaluative components. Their harmonious development ensures the effectiveness of professional activity.

3. Digital platforms such as Google Classroom, Moodle, Kahoot!, Quizizz, LearningApps, Mentimeter, Genially, and Mozaik Education possess extensive didactic opportunities for developing the methodological knowledge, skills, and abilities of future biology teachers.

4. The use of virtual laboratories, digital simulations, and interactive educational resources serves to develop the competencies of future teachers in deeply understanding biological processes, creating digital educational resources, and organizing modern lessons.

5. Organizing students' independent educational activities in a digital educational environment, maintaining an electronic portfolio, and using digital assessment tools are of great importance in developing all components of methodological competence.

6. The results of the experimental work showed that the educational process organized on the basis of digital technologies serves to significantly increase the professional motivation, methodological training, and digital competencies of future biology teachers.

7. The use of pedagogical models and technologies in higher education institutions aimed at developing the methodological competence of future biology teachers in a digital educational environment serves to improve the quality of teacher training.

Thus, it was established that the development of the methodological competence of future biology teachers in the context of the digitalization of education is inextricably linked to the effective organization of the digital educational environment, the targeted use of innovative platforms, and the support of students' independent educational activities.

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