Implementation Of Effective Methodological Approaches Based On Digital Educational Technologies In Teaching The Subject Biotechnology

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ANNOTATION: This article analyzes the role and importance of digital educational technologies in teaching biotechnology in modern higher education. Through the use of virtual laboratories, simulation programs, interactive materials, and online assessment systems in the educational process, students develop skills in combining theoretical knowledge with practice, independent thinking, and problem-solving. With the help of digital methods, an individual and differentiated approach, blended learning, project and problem-based learning are effectively implemented. Also, digital technologies serve the formation of students' information skills, digital literacy, critical thinking, communicative and creative competencies. Therefore, teaching biotechnology based on digital educational technologies is of great importance as one of the modern pedagogical issues..

KEY WORDS: biotechnology, digital educational technologies, virtual laboratory, flipped classroom (reverse classroom model), problem-based and project-based learning, competency development, blended learning, individual approach.

INTRODUCTION

In recent years, the higher education system has been inextricably linked with digital technologies, transforming the educational process into a more interactive, effective, and individualized form. The development of students' independent thinking, analysis of problem situations, and practical skills is recognized as one of the main tasks of modern higher education. From this point of view, natural sciences, in particular, the science of biotechnology, with its complex theoretical knowledge and richness of laboratory practice, require the formation of deep knowledge and practical skills in students.

Traditional teaching methods are often limited to conveying theoretical knowledge and do not sufficiently involve students in independent research and problem-solving. Therefore, the introduction of digital educational technologies in higher educational institutions is an important tool for increasing students' activity in science and the quality of their knowledge.

Digital educational technologies - virtual laboratories, simulation programs, interactive presentations, and online assessment systems - not only make the lesson interesting, but also allow students to study complex biological processes in a safe environment, conduct experiments, and analyze the results. At the same time, through their application, the educational activity of students is organized individually, the effectiveness of lessons increases, and the educational process acquires a more interactive form [1].

From this point of view, the introduction of effective methodological approaches based on digital educational technologies in teaching biotechnology is considered an urgent pedagogical issue in higher education. The use of digital tools in the educational process helps students to apply research approaches in practice, strengthen theoretical knowledge, and understand complex biological processes.

The process of teaching with the help of digital methods creates an opportunity for student activity,

consolidation of knowledge, and development of practical skills. At the same time, they serve to organize the educational process in higher educational institutions in an interactive, individual, and safe environment, which creates the basis for the effective organization of modern biotechnology education.

Main Part. Biotechnology occupies a special place in the system of modern biological sciences and is based on the use of living organisms, their cells, tissues, and biological processes for human needs. This science, along with fundamental biological knowledge, is distinguished by the fact that it combines practical and technological approaches.

One of the main features of the science of biotechnology is its interdisciplinary integrative nature. This science develops in close connection with genetics, molecular biology, microbiology, biochemistry, bioinformatics, chemistry, and technology. Therefore, in the process of studying biotechnology, students are required to combine and comprehensively analyze knowledge from various disciplines.

Another important feature of the science of biotechnology is the close connection of theoretical knowledge with practical activity. Laboratory experiments, experimental studies, production processes, and real technological problems occupy an important place in the content of science. This situation requires the use of methods based on practical exercises, experiments, and modeling, not limited to traditional lecture methods in teaching biotechnology.

Another peculiarity of the science of biotechnology is that it has a rapidly developing and constantly updated scientific content. New scientific achievements are constantly emerging in areas such as genetic engineering, cloning, cell technologies, and recombinant DNA technologies. Therefore, educational materials and teaching methods should be constantly updated based on modern requirements [2].

Also, the science of biotechnology requires a high level of visualization and modeling. Such intracellular processes as molecular processes, enzymatic reactions, and gene expression are difficult to explain in simple words, and it is more effective to teach them through graphs, animations, virtual laboratories, and digital models.

One of the important features of biotechnology is its direct connection with human life, health, and the environment. The achievements of this science are widely used in the fields of medicine, agriculture, the food industry, pharmaceuticals, and ecology. This serves to form in students an understanding of the social significance of science, ecological and bioethical responsibility [3].

Another important aspect is the presence of security and bioethics issues. When working with biotechnological processes, it is important to observe the rules of biological safety, understand and comply with bioethical norms. This situation requires the formation of a responsible attitude in students when teaching biotechnology. The science of biotechnology is distinguished by interdisciplinary integration, practical orientation, openness to scientific innovations, the need for visual and digital tools, as well as social and bioethical responsibility. These features further strengthen the need to apply effective methodological approaches based on digital educational technologies in teaching biotechnology.

The role of digital educational technologies in education. The development of the modern education system is closely related to the widespread introduction of information and communication technologies, and digital educational technologies are becoming an important component of the organization of the educational process. Digital technologies play an important role in updating the content, forms, and methods of education, increasing the effectiveness of the educational process, and expanding students' opportunities for independent learning.

Digital educational technologies are understood as a set of pedagogical technologies based on the use of computer technologies, Internet resources, multimedia tools, e-learning platforms, virtual and distance learning environments in the educational process. With the help of these technologies, it is possible to individualize the educational process, adapt it to the interests and abilities of students.

The main role of digital educational technologies in education is manifested, first of all, in the visualization and facilitation of understanding of educational content. Explanation of complex scientific concepts, processes, and phenomena through animations, graphic models, video lessons, and interactive materials serves the conscious assimilation of knowledge by students. This is especially important in such

sciences as biology and biotechnology.

Also, digital technologies allow increasing student activity and turning them into active participants in the educational process. Interactive tasks, online tests, virtual discussions, and project activities develop students' independent thinking, problem-solving, and teamwork skills.

One of the important aspects of digital educational technologies is the possibility of organizing distance and blended learning. The placement of educational materials through electronic platforms, the completion of assignments online, and assessment ensure the continuity of the educational process. This helps maintain the quality of education in various conditions, including emergencies.

Digital educational technologies also serve to effectively organize the activities of teachers. With the help of electronic resources, the possibilities of lesson planning, monitoring the level of student mastery, rapid analysis, and feedback are expanding. As a result, the teacher will be able to focus more on methodological and creative activity.

In addition, digital technologies make it possible to implement a differentiated and individual approach to education. Students form their educational trajectory by completing tasks of different levels in accordance with the level of knowledge and the pace of assimilation. This has a positive impact on the personal development of students.

The role of digital educational technologies in education is also clearly manifested in the implementation of competency-based learning. Competencies such as working with information, digital literacy, critical thinking, and independent decision-making are effectively formed in the digital environment [4].

Effective methodological approaches based on digital educational technologies. Today, the use of digital educational technologies in the educational process requires not only the renewal of teaching aids, but also a radical improvement of teaching methods. The organization of education in the digital environment requires the teacher to apply innovative methodological approaches, and students - a position of independent and active learning. Especially in such complex and practically oriented disciplines as biotechnology, the introduction of effective methodological approaches based on digital educational technologies is of great importance.

The following methodological approaches are effective in teaching biotechnology based on digital technologies:

Flipped classroom model. In teaching based on digital educational technologies, the Inverse Classroom model is one of the effective methodological approaches. In this model, students independently master the theoretical part of the topic before the lesson through video lessons, electronic lectures, and interactive materials. During the lesson, discussion, analysis of problem situations, practical exercises, and project activities are carried out. This approach allows for allocating more time to laboratory work and practical exercises in biotechnology.

Problem-based learning and project-based approach. The problem-based learning approach offers students to solve real-life biotechnological situations using digital models, simulators, and virtual experiments. In this process, students develop the skills of independent thinking, analysis, and drawing scientifically based conclusions.

The project-based learning approach allows for the preparation of project work in the field of biotechnology using small groups. Students collect information from digital sources, defend the results in the form of presentations, videos, or electronic reports. This forms competencies in creativity, teamwork, and digital literacy.

Differential and individual approach. With the help of digital educational technologies, it is possible to give assignments corresponding to the level of knowledge of students on electronic platforms, form an individual educational trajectory, and take into account the pace of their assimilation. As a result, the individual capabilities of each student are taken into account.

Mixed learning and assessment. Mixed learning (blended learning) complements classroom activities with online resources, which serves to strengthen and expand students' knowledge. Also, interactive

assessment systems (online tests, electronic portfolios) allow for a fair assessment of students' knowledge and skills and provide prompt feedback [5].

Virtual laboratories and simulators. Virtual laboratories and simulators are of particular methodological importance in teaching biotechnology. Also, through bioinformatic modeling, students' professional competencies are developed. Virtual laboratories allow visualization and independent study of complex molecular processes, and also increase student motivation. The diagram below shows what advantages virtual laboratories and simulators offer in teaching biotechnology (Figure 1).
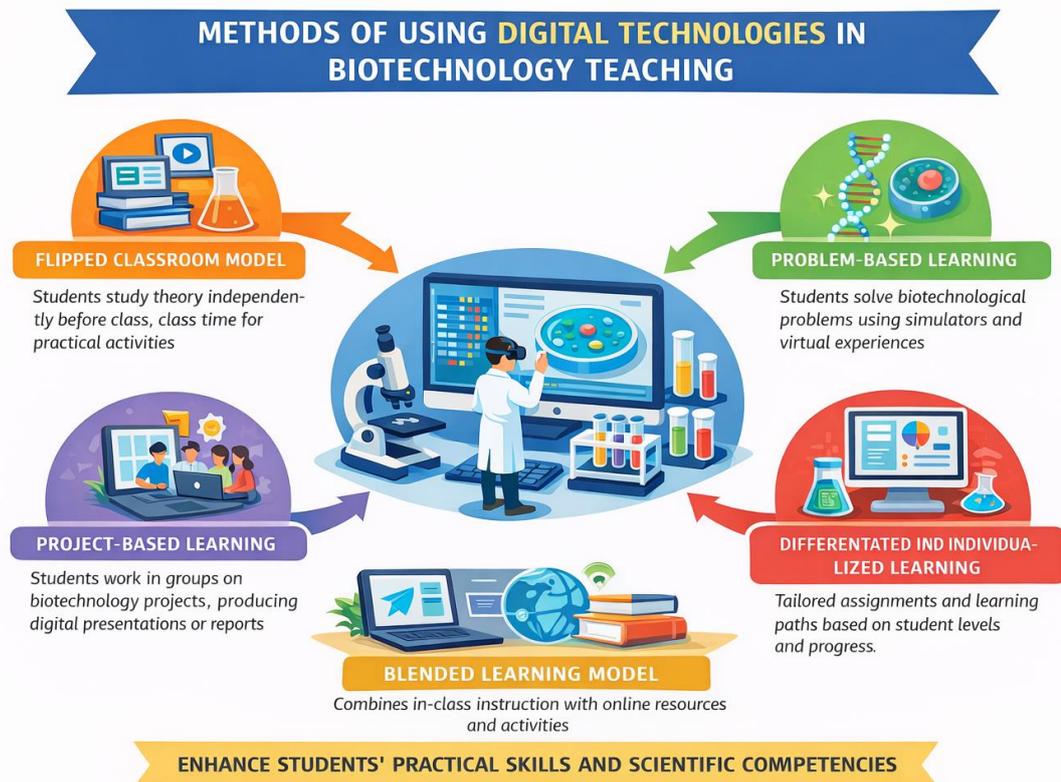
Figure 1. Advantages of virtual laboratories and simulators in teaching biotechnology.

The importance of digital technologies in the development of student competencies. Digital technologies play an important role in the development of students' competence in working with information. In the process of using electronic resources, scientific databases, and online platforms, students acquire skills in searching, sorting, analyzing, and evaluating information. This serves to strengthen their ability to think critically.

Furthermore, digital technologies shape the competence of digital literacy. Working with various programs, educational platforms, virtual laboratories, and interactive tools increases students' adaptability to the modern technological environment. This competence is considered important in future professional activities.

The educational process, organized on the basis of digital technologies, develops the competence of independent learning. Students will have the opportunity to independently supplement their knowledge, self-monitor, and assess their level of mastery using electronic textbooks, video lessons, and online assignments. As a result, they develop responsibility and skills for self-improvement.

In addition, digital technologies play an important role in the development of communicative competence. Online discussions, forums, group projects, and remote collaboration processes develop students' ability to clearly express their thoughts, work in a team, and cultivate a culture of communication.

Solving problem situations in the digital environment, conducting virtual experiments, and developing projects develops problem-solving and critical thinking competencies in students. Students learn to analyze a given situation, consider several solution options, and make scientifically based decisions.

Digital technologies also serve the development of creative competencies. In the process of creating multimedia products, preparing presentations, and developing digital content, students have the opportunity to express their creative ideas [6].

Also, digital educational technologies play an important role in the formation of professionally oriented competencies. In particular, working with digital laboratories, bioinformatics programs, and modeling tools in biotechnology increases students' preparedness for future professional activities.

In conclusion, the introduction of effective methodological approaches based on digital educational technologies in teaching biotechnology is an important factor in improving the quality and effectiveness of education. Virtual laboratories, interactive platforms, problem-based and project-based teaching methods increase students' interest in the subject, allow combining theoretical knowledge with practice. Therefore, the widespread introduction of digital educational technologies into the process of teaching biotechnology is pedagogically expedient.

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