ANALYSIS OF THE EFFECTIVENESS OF USING DIGITAL TECHNOLOGIES IN TEACHING FIRST-YEAR MEDICAL STUDENTS

АНАЛІЗ ЕФЕКТИВНОСТІ ВИКОРИСТАННЯ ЦИФРОВИХ ТЕХНОЛОГІЙ У НАВЧАННІ СТУДЕНТОВ-МЕДИКІВ 1-ГО КУРСА

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ABSTRACT

In the modern world, the amount of knowledge has increased significantly, and therefore, there is a constant need to acquire and update it. Medicine is a rapidly developing field, and it is important for the future and working doctor to constantly improve their professional skills using modern technologies.

*The **purpose** of this study is to determine*

У сучасному світі обсяг знань значно збільшився і тому весь час виникає потреба в їх здобутті та оновленні. Медицина є однією з тих галузей, яка швидко розвивається, і для майбутнього та працюючого лікаря є важливим постійно покращувати свої професійні навички, використовуючи сучасні технології.

Мета. *Метою даного дослідження є*

the most effective modern information technologies and the level of their effectiveness in the study of the subject "Medical Biology," as well as the attitude of students to their use and the impact on the ability to perceive educational material.

Methodology. The study employed a complex set of research methods, including theoretical (such as analysis of scientific sources, pedagogical and teaching materials, and comparison) and empirical (such as summarizing teaching experience and interviewing) methods. First-year students (130) of the medical university were involved in the survey.

Results. From our experience, using problem lecture technology in the learning process is more appropriate. It is based on a problematic presentation of the material in the form of contradictions, certain contradictions, the discussion of which makes it possible to keep students active, encourage them to dialogue or even debate. Problem presentation of the material stimulates the mental abilities of students and develops critical thinking, scientific, and cognitive activity.

For data visualization, in addition to presentations and videos, mind maps were created, which made it possible to direct students not to memorization, but to reflection and awareness of cause-and-effect relationships and connections. The most effective way to create a mental map is to use the "brainstorming" technology. Students offer several variants of ideas for solving a specific problem; everyone expresses their own opinion and then combines the information into one collective solution and depicts it in the form of a diagram.

To combine theoretical training and practical skills (simulating biological processes), we used the Labster platform covering different topics in biology, such as genetics, ecology, and cell biology.

When studying Medical Biology, the most popular platform used by students was edX (53.1%). Regarding the forms of education, 37.9% of respondents chose the form, 38.6% the mixed form, and the rest were undecided.

Conclusions. Modern information technology has become an integral part of the learning process in medical higher education, improving the quality of students'

визначення найбільш ефективних сучасних інформаційних технологій та рівня їхньої ефективності під час вивчення предмета «Медична біологія», а також ставлення студентів до їхнього використання та впливу на здатність сприйняття навчального матеріалу.

Методи. У дослідженні використано комплекс методів дослідження, серед яких теоретичні (аналіз наукових джерел, педагогічних та навчально-методичних матеріалів, порівняння) та емпіричні (узагальнення педагогічного досвіду та інтерв'ювання). В опитуванні були залучені студенти (130) першого курсу медичного університету.

Результати. З нашого досвіду у процесі навчання доречніше використовувати технологію проблемної лекції. В її основі лежить проблемний виклад матеріалу у вигляді суперечностей, певних протиріч, обговорення яких дає змогу утримати студентів активними, спонукати їх до діалогу чи навіть дискусії. Проблемний виклад матеріалу стимулює розумові здібності студентів, розвиває критичне мислення, науково-пізнавальну діяльність.

Для візуалізації даних, окрім презентацій та відео, ми створювали ментальні карти, що дало можливості спрямовувати студентів не на запам'ятовування, а на роздуми та усвідомлення причинно-наслідкових залежностей та зв'язків. Найефективнішим у створенні ментальної карти є застосування технології "мозкового штурму". Студенти пропонують декілька варіантів ідей розв'язання конкретної задачі, кожен висловлює власну думку, а потім об'єднують інформацію в одне колективне рішення та зображують у вигляді схеми.

Щоб об'єднати теоретичну підготовку та практичні навички (моделювати біологічні процеси), ми використовували платформу Labster, яка охоплює різні теми біології, такі як генетика, екологія та клітинна біологія.

При вивченні медичної біології найпопулярнішою платформою, якою користувалися студенті, була edX (53,1%). Стосовно форм навчання, то 37,9% опитаних обрали аудиторну форму навчання, 38,6% змішану форму, решта – не визначилася.

Висновок. Сучасні цифрові технології стали невід'ємною частиною навчального процесу у медичних ВНЗ, підвищуючи якість підготовки студентів до вимог сучасної медицини.

preparation for the requirements of modern medicine. The most effective methods for teaching "Medical Biology" include problem-based lectures with presentations, electronic resources, videos, virtual labs, websites, and mind maps. A blended approach that combines multiple technologies enhances the learning process and helps develop essential professional skills in future doctors.

Keywords: *educational process, mind maps, problematic lecture, virtual laboratories.*

Найбільш ефективними методами викладання «Медичній біології» є проблемні лекції з презентаціями, електронні ресурси, відеоматеріали, віртуальні лабораторії, веб-сайти та ментальні карти. Змішаний підхід з поєднанням разом декількох технологій покращує процес навчання та допомагає формувати основні професійні навички у майбутніх лікарів.

Ключові слова: *віртуальні лабораторії, ментальні карти, освітній процес, проблемні лекції.*

INTRODUCTION

Continuous education is a component of modern living conditions. Education is increasingly integrated with the idea of "lifelong learning", which involves learning and acquiring new knowledge and competences throughout life using the latest information technologies (Holovanova, et al., 2020; Haleem, et al., 2022; Lukianova, 2011; Volkova, 2018; Skvortsova, et al., 2022). In recent years, modern information technology has revolutionized various fields, including medical education, which has undergone significant transformation to meet the demands of contemporary society.

The rapid development of technological processes in healthcare has made integrating advanced technologies into medical education increasingly important. Innovative directions of transformation of the modern educational process are the introduction of electronic and distance technologies, the formation of a digital educational environment, the creation of virtual training systems that are as close as possible to real conditions, the introduction of artificial intelligence (AI) tools in the creation of educational materials, in the personalization, automation and availability of educational content (Grimwood et al., 2020; Chatterjee et al., 2021; Narayanan et al., 2023; Alam et al., 2023; Chetveryk, & Veretiuk, 2024).

The study of biology is an integral part of medical education, therefore the use of innovative technologies in this field allows us to significantly improve the training of future doctors.

The **purpose** of our work was to determine the most effective modern information technologies and their level of effectiveness in the study of Medical Biology, as well as students' attitudes to their use and their impact on their ability to perceive educational material.

METHODOLOGY

The study employed a complex set of research methods, including theoretical (such as analysis of scientific sources, pedagogical and teaching materials, and comparison) and empirical (such as summarizing teaching experience and interviewing) methods. The authors conducted a review of psychological and pedagogical materials devoted to the development of teaching methods in the modern educational process, including various forms and methods of training utilizing the Microsoft Office 365 Teams platform.

A total of 130 first-year medical university students participated in the interviews about their experience of using information technologies in the study of medical biology and their preferences. The quality of learning was assessed through a range of methods, including tests, oral and written surveys, problem-solving exercises, and analysis of students' responses to instructor questions.

RESULTS

The learning process requires special efforts, which depend not only on the student's abilities and moral state, but also on learning methods that would ensure a sufficient level of knowledge. A born at the beginning of the 21st century has a "clip-like" way of perceiving information, which is characterized by reading only superficial facts.

Clip thinking allows you to quickly familiarize yourself with information but causes a shortage of deep analysis and understanding of the content itself (Kornuta, et al., 2017; Melnyk, et al., 2020).

Logical thinking, which allows you to delve into information, carry out an analytical review of it and gain personal experience, is formed in the process of learning and learning scientific concepts (Vorontsova, 2017).

In view of the above, the search for learning tools that could solve this problem remains relevant. We tried to determine the most appropriate methods in studying the subject of Medical Biology, as well as to investigate their degree of effectiveness at all stages of education (explanation of the basics of the discipline, assimilation of the studied material and its control).

In this work, we will clarify only some aspects of the specifics of teaching the subject "Medical Biology". It is not immediately possible to detect all the problems that arise in this case. This requires a certain amount of time and effort and will be carried out in the future.

Our experience shows that the most common nowadays and the simplest interactive tool for presenting information is a Problematic lecture, which is the basic source of information for those seeking knowledge and expresses the content of the academic discipline, the level of scientific and applied application, and novelty. The topics of the lectures are very diverse, and they cover the main topics of the subject, targeting students to study the most significant foundations of the studied discipline.

Thus, the introductory lecture introduces students to the purpose of the course, its role and place in the system of educational disciplines, puts forward scientific problems and hypotheses, and outlines the perspective of the development of science and its connection with practice. In the introductory lecture, the lecturer shows the connection of theoretical material with practice, with the personal experience of students and the practice of their future work.

The lecture is a source of scientific information adapted for students. Some sections and topics of the course cause great difficulties during independent study from textbooks, and study guided by the lecturer requires methodical revision (Fig. 1).

Figure 1

Online Problematic lecture on Medical Biology in Microsoft Teams.

With the help of the use of technical means of education (audio and/or video equipment) during the lecture, the necessary type of thinking, in particular professional, is formed in the students. Thus, 3D technology is a very convenient additional tool for explaining new topics to students when studying the basics of the structure and functions of the cells that make up the human body. 3D models of high image quality, which cover all the cells of the human body, allow you to see the structure of individual cells or in a complex of tissues.

We see organoids separately; we can demonstrate the functions of cellular components to students. The technology demonstrates the differences between plant and animal cells and also indicates the characteristic features of their similarities. The structures that are located in the cytoplasm and in the nucleus are clearly visible.

This program can be used as a virtual reality helmet as if being inside a cell. Or without a helmet – on the screen, which allows the teacher to demonstrate all the structures, for example, in an online class. Students view images on their computers. Since all processes take place dynamically, we can use them to create our own video content, which can be shown to students on video screens installed in all classrooms. Visual design helps to structure information for faster and more effective memorization.

To combine theoretical training and practical skills, which allows students to apply their knowledge in practice to solve problems, we used the "case method". For example, "Examination of newborns in one of the Ukrainian cities revealed a baby with phenylketonuria. The baby's parents do not suffer from this disease and have two other healthy children. Specify the most likely parents' genotype with phenylketonuria gene". Solving the situational problem requires focusing on many different aspects, including knowledge about cells, genes, mutations, types of inheritance, and the nature of the disease. A detailed analysis of a specific case or real situation prompts the student to

search for alternative methods of solution and make the optimal solution to the problem.

The most convenient and effective tool for data visualization is mind maps. The introduction of mental maps into the educational process makes it possible to direct students not to memorization but to reflection and awareness of cause-and-effect relationships and connections. The use of mental maps allows you to develop the skills of such mental operations as a comparison, analysis, abstraction, generalization, and inference, stimulate cognitive processes, and develop communication and intelligence skills (Abuvatfa et al., 2019; He et al., 2024; Koltunovych et al., 2019; Lisetska et al., 2022).

Here is an example of a mental map that we use in practical classes (Fig. 2). The main image here is Protozoa, which are represented by several classes that include parasites – the causative agents of human diseases. In this way, the causes and consequences of human diseases are determined, and cause-and-effect relationships are formed. For better memorization, we use pictures with examples that complement key concepts. This structuring of already acquired knowledge makes generating it into its own understandable logical scheme possible. This scheme demonstrates the possibility of combining fragments of information with each other using various connections.

Figure 2
A fragment of the mental map of the practical lesson "Protozoa – human parasites".
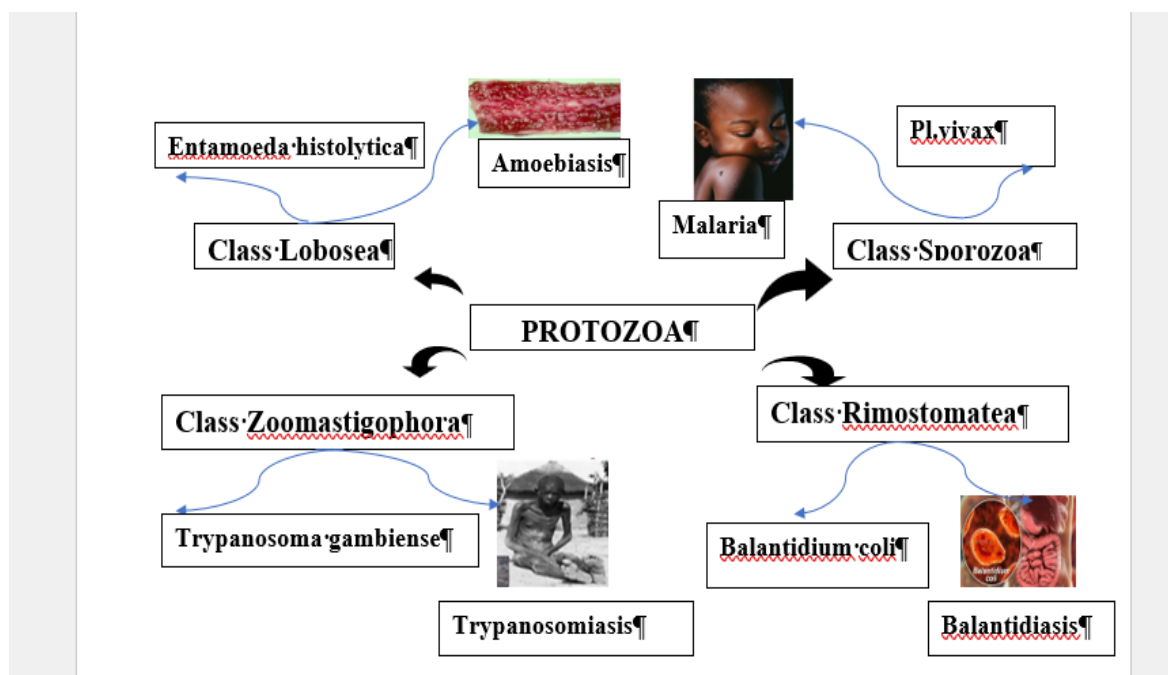
Studying some topics of Medical Biology (Cell division, Hereditary human diseases) conducted virtual laboratory work using the Labster platform. They enable students to study and conduct experiments in biology that may not be possible in the real world due to the complexities of research facilities. In addition, the use of virtual laboratory work provides an opportunity to simulate biological processes that cannot be visually investigated in laboratory conditions. By immersing students in the learning material, virtual reality can make learning more engaging and memorable.

With the advent of accessible AI projects such as ChatGPT, there has been an increased interest in AI tools in all walks of life. AI provides various resources and technologies that can be used in the educational process.

At our university, we have taken significant steps to incorporate innovative technologies, including AI, to make teaching medical biology more effective, engaging, and efficient. By integrating AI into the learning process, we aim to equip students with the knowledge and skills needed for further study in preclinical and clinical disciplines.

Studying Medical Biology is an important stage in the formation of a doctor's competencies. During training, students get acquainted with medical terms, functional features of the body, the structure of cells and tissues, the basics of human genetics, and medical parasitology. This knowledge can later be used to understand the causes of diseases, diagnosis, treatment, and prevention.

Today, there are various information technologies. One of the ways to increase the effectiveness of the educational process, considering the peculiarities of the modern student's thinking, is the inclusion of interactive techniques. It is more appropriate to use the technology of a problem lecture. Such lectures are based on the material in the form of contradictions, certain contradictions, and discussions, which makes it possible to keep students active and encourage them to engage in dialogue or even a discussion.

The problem-based presentation of the material stimulates students' mental abilities, develops critical thinking, scientific and cognitive activity and activates those seeking education to master the subtleties of the future profession. Visualization of lectures makes them as effective as possible in understanding the studied material (Bekzhanova et al., 2015; Mutrofin et al., 2017). Also, during the lecture, the teacher can conduct an online survey to determine the level of accessibility and assimilation of the studied subject.

At different stages of the educational process, the presentation of the basics of the discipline being studied, the stage of assimilation of new material, and the stage of its revision, we use mental maps. When teaching the basics of the discipline, a mental map is prepared by the teacher for a lecture or class and is given to students to familiarize them with the corresponding explanation. The use of mind maps during learning facilitates this process, because the analysis of this material takes place. During the control of the studied material, the teacher can determine the level of assimilation of the topic based on the analysis of mental maps created by students. This makes it possible to adjust the learning process.

The most effective innovative method in creating a mental map is the use of "brainstorming" technology. Participants find several options, ideas for solving a specific problem, everyone expresses their own opinion, and then combine the information into one collective (team) solution and depict it in the form of a scheme (Vorontsova, 2017; Shen, et al., 2018).

Using the Labster platform, which offers a wide range of virtual lab simulations, we cover various biology topics such as genetics, ecology and cell biology. Students can manipulate the virtual environment and test their hypotheses regarding the inheritance patterns of genetic diseases or normal human traits. The Labster platform

provides students with immediate feedback on their experiments, allowing them to adjust their hypotheses and methods based on the results and understand basic concepts of biology and the scientific method. This method in the study of the subject of Medical Biology makes it possible to use practical works, mainly to check the amount of knowledge and laboratory works – to assess the ability of students to apply this knowledge.

The integration of AI into medical biology educational process has been able to provide many benefits. One of the most significant advantages is increased accessibility. Students can engage with AI-driven tools from any location, making education more inclusive. Furthermore, using AI improves learning outcomes by providing dynamic, interactive experiences that increase student engagement and retention of information.

The use of AI technology has opened up new possibilities for streamlining and enriching the creation of educational content. Traditionally, educational material has been developed through conventional methods involving extensive manual effort from educators, instructional designers, and content creators. These methods often entail significant time and resources to produce textbooks, lectures, and supplementary resources that cater to diverse learning needs. By leveraging advanced algorithms and data analysis, AI systems can now assist in generating and customizing educational material in ways that were previously unattainable (Alam, F. et al., 2023; Narayanan, S. et al., 2023).

Moreover, AI-driven tools are revolutionizing the production of educational material by automating the creation of text, quizzes, and multimedia content. This automation not only accelerates the development process but also ensures a consistent quality of resources, enabling educators to focus more on interactive teaching and student support. For instance, AI systems can generate adaptive learning paths, design interactive simulations, and even create educational videos with minimal manual intervention (Ezzaim, A., et al., 2023; Diwan, C., et al., 2023).

We see a promising direction for the use of AI technologies in automating routine processes of analyzing students' progress, creation of own projects for laboratory classes using virtual reality tools, as well as creation of animated electronic textbooks.
As we analyze the application of AI in the learning process, it is important to consider both the potential benefits and challenges associated with this technology.

First of all, the main problem in the application of AI in the teaching of biomedical disciplines is the lag of teachers' knowledge and skills behind the progress of AI, which limits and inhibits its implementation in the educational process. Another challenge is the cost associated with implementing and maintaining AI technologies, which can be prohibitive. We are currently using free versions of AI platforms that provide limited features.

We have also taken measures to prevent cheating with tools like ChatGPT. To maintain academic integrity, we design personalized tests that are tailored to each student's learning history and performance. These tests are unique to the individual, making it difficult for them to rely on AI-generated responses. This approach not only discourages cheating but also promotes a deeper understanding of the material.

Addressing these challenges is crucial for ensuring that AI's integration into education is both effective and responsible.

We also analyzed which modern technologies are most often used by students in the study of Medical Biology. According to the survey, 34.4% of respondents use lecture material, supplementing their knowledge with information from electronic textbooks or manuals – 36.6%, Video lessons in medical biology on educational platforms – Khan Academy, Coursera are viewed -17.6%, 11.4 % of respondents listen to webinars and take courses on the edX platform: The presented results almost coincide with our data, which we obtained as a result of the analysis of the forms and methods of using modern information technologies in the process of teaching the subject Medical Biology (Fig. 3).

Figure 3

Forms and methods of modern informational technologies in teaching "Medical Biology"
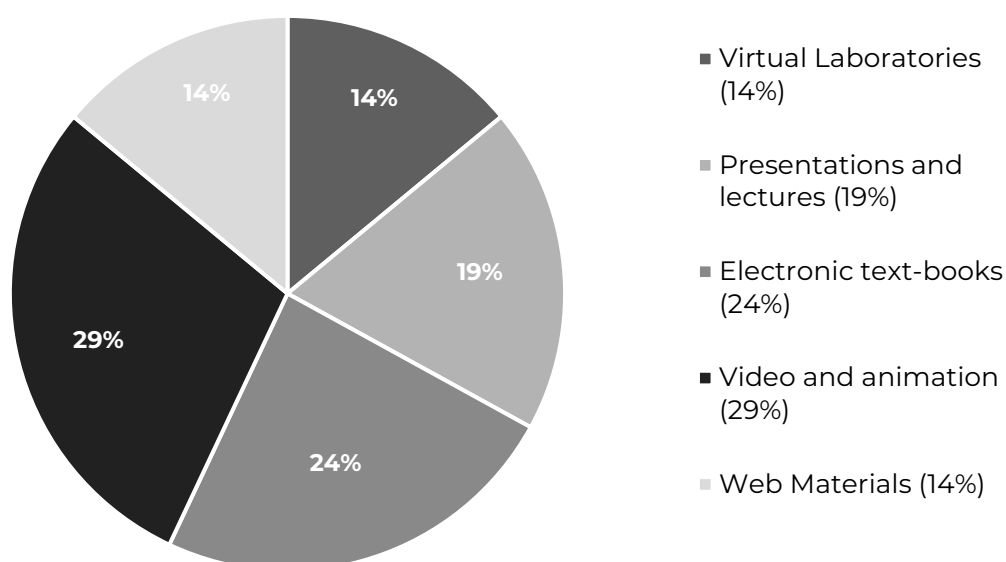
The form of education has also acquired a certain importance for those seeking education. The mixed form turned out to be the most attractive (for 38.6% of the surveyed students), 23.5% said that they would like to study in an online synchronous and online asynchronous form, 37.9% of respondents chose the classroom form of education.

DISCUSSION

AI-based tools are revolutionizing the production of educational materials by automating the creation of text, tests, and multimedia content. This automation not only speeds up the development process but also ensures consistent quality of resources, allowing educators to focus more on interactive learning and student support. AI tools are used to create illustrations and presentations for lectures and classes. The Deepai and Microsoft Designer services help to create illustrations based on text descriptions, and Paint by Text allows us to modify illustrations. The Pictory service is used to create short summary videos from a video of a class or lecture recorded in Teams. ChatGPT, which students actively use to complete assignments or

take tests, becomes a convenient tool for the teacher to create personalized assignments of varying complexity.

CONCLUSIONS

Modern information technology has become an integral part of the learning process in medical higher education, offering innovative tools and resources that enhance the quality of education and better prepare students for the demands of modern medicine.

The most effective methods of using information technology to develop the professional competencies of future doctors in teaching "Medical Biology" include problem-based lectures with presentations, electronic resources, video materials, virtual laboratories, websites, and the creation of mind maps. The selection of specific methods should be tailored to the content of each topic to optimize learning outcomes.

An innovative approach that combines multiple methods and forms of information technology creates a more effective and dynamic learning process, fostering the development of essential professional skills in future doctors.

CONFLICT OF INTERESTS

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