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THEORETICAL CONSTANTS OF DEVELOPMENT OF CREATIVE THINKING OF FUTURE DOCTORS IN THE PROCESS OF PHARMACOLOGICAL TRAINING

The theoretical basis for developing future doctors' creative thinking skills during their pharmacological training is discussed in this article. The relevance of this topic is due to the current challenges in medicine, which require not only a high level of doctors' knowledge but also their ability to think outside the box and to be creative in clinical situations. This study focused on how pharmacological training can help future doctors develop creative skills.

Particular attention is paid to pedagogical approaches such as problem-based learning, interactive methods, and innovative technologies. Problem-based learning is seen as a way to develop critical thinking and the ability to solve complex clinical cases by applying pharmacological knowledge in practice. Interactive methods such as group discussions, simulations, and role-playing games contribute to the development of the ability to make quick decisions under conditions as close to real life as possible. Virtual simulations and multimedia programs allow students to experiment with different therapeutic approaches and analyze their effects.

The article also emphasizes the importance of critical thinking about pharmacological knowledge, which allows students not only to memorize information and use it creatively to solve nonstandard medical problems. Stimulating intrinsic motivation and teamwork promotes creative thinking when students actively discuss ideas and generate innovative treatment approaches.

This study focused on the analysis of online tools for simulating clinical cases, which is an important component of modern medical education. Platforms such as Body Interact and Prognosis: Your Diagnosis" simulate real clinical situations, allowing students to make informed decisions and analyze their consequences. Tools such as Lecturio and OpenLabyrinth offer interactive learning materials and tests that promote deeper learning. Virtual reality, as in the case of SimX, helps create realistic clinical simulations for teamwork. These tools provide flexible learning, realistic clinical cases, and support the development of creative thinking and decision-making skills. They help future doctors prepare for the real world by integrating theory and practice.

The application of these approaches will enable future doctors not only to successfully use pharmacological knowledge in real life but also to develop the ability to think creatively, which is a key aspect of modern medical practice.

Keywords: *creative thinking; educational environment; creative personality; pharmacological training; interactive methods; problem-based learning;, innovative technologies*

ТЕОРЕТИЧНІ КОНСТАНТИ РОЗВИТКУ КРЕАТИВНОГО МИСЛЕННЯ МАЙБУТНІХ ЛІКАРІВ У ПРОЦЕСІ ФАРМАКОЛОГІЧНОЇ ПІДГОТОВКИ

Розглядаються теоретичні константи розвитку креативного мислення майбутніх лікарів у процесі фармакологічної підготовки. Актуальність теми зумовлена сучасними викликами у сфері медицини, де здатність до нестандартного мислення та творчих підходів є важливими елементами професійної компетентності лікаря. Акцентується увага на необхідності розвитку креативності, яка допомагає майбутнім лікарям ефективно вирішувати складні клінічні завдання, особливо у випадках нестандартних клінічних ситуацій, що потребують творчих рішень.

Основна увага статті приділена педагогічним підходам, які сприяють формуванню креативного мислення, серед яких виділяються: проблемно-орієнтоване навчання, інтерактивні методи та використання інноваційних технологій в освітньому процесі. Проблемно-орієнтоване навчання дозволяє здобувачам вищої освіти самостійно вирішувати складні клінічні випадки, застосовуючи набуті фармакологічні знання для аналізу та синтезу інформації. Інтерактивні методи навчання, такі як дискусії, рольові ігри та симуляції клінічних випадків, допомагають розвивати здатність до швидкого прийняття рішень у реальних умовах. Інноваційні технології, зокрема віртуальні симуляції та мультимедійні програми, дозволяють здобувачам вищої освіти експериментувати з різними терапевтичними підходами та моделювати наслідки своїх рішень.

Наголошується на необхідності критичного мислення, що розвивається через аналіз складних клінічних випадків. Створення творчих завдань і використання сучасних технологій також сприяє формуванню креативних навичок майбутніх лікарів.

Застосування запропонованих методів дозволить студентам не лише запам'ятовувати інформацію, а й знаходити нові, нестандартні рішення для подальшого використання в їхній професійній діяльності.

Ключові слова: *креативне мислення; освітнє середовище; творча особистість; фармакологічна підготовка; інтерактивні методи; проблемно-орієнтоване навчання; інноваційні технології*

Relevance of the problem. In modern rapidly evolving medical and pharmaceutical industry, there is a need to train doctors capable of thinking outside the box and using creative approaches to solve complex medical problems. Creative thinking has become one of the main competencies of a modern doctor, as it allows to find optimal solutions in non-standard clinical situations. The pharmacological training of future doctors plays a significant role in this process, as it is within the framework of pharmacology that the skills of analyzing and using a large amount of information, as well as the ability to create new therapeutic approaches are formed.

At the same time, the relevance of the chosen problem is due to a number of factors that characterize modern medicine. The first one is that the rapid progress in the field of medicine and pharmacology requires doctors to adapt to new knowledge, technologies, and treatments. The second one is that the global changes in healthcare systems caused by pandemics, demographic changes, and changes in lifestyles require doctors to be flexible and able to make quick decisions. In this context, creativity is becoming an important tool for physicians to find effective solutions in non-standard situations, develop new therapeutic strategies, and adapt treatment to the needs of a particular patient.

Thirdly, modern learning technologies, including online tools and simulation platforms, create new opportunities for the development of creative thinking among medical students. They allow for the integration of theory and practice, enabling students to experiment with different clinical scenarios and receive immediate feedback. This contributes to the development of critical thinking skills, analysis and synthesis of information, which are key to the successful professional activity of a doctor.

Analysis of previous studies and publications. In the context of the study of the development of creative thinking of future medical professionals, it should be noted that a significant number of works are devoted to the use of innovative teaching methods, interactive technologies and game approaches. The team of scientists emphasizes that gaming technologies contribute to the development of creative potential and active participation of students in the learning process, which is an important aspect for any specialty, including the medical field, where it is necessary to develop creative thinking to solve complex clinical problems [1]. O. Borovets and T. Yakovyshyna consider the conditions for the formation of creativity in higher education, in particular in the educational process aimed at forming a creative personality [3]. Another study focuses on the introduction of digital technologies in the educational process. It is important that the use of tools such as virtual simulations and online platforms contributes to the development of skills in analysis, decision-making, and creative approach to solving medical problems [5].

Y. Kaliuzhna studies the methodology of developing students' creative potential through independent educational activities [6]. N. Kurmisheva and O. Makhla investigate creativity as an important element of teachers' professional competence. They emphasize that creativity is key not only in pedagogy, but also in any profession, including medicine, where a creative approach to patient care is an integral part of professional competence [7; 9].

Highlighting the previously unresolved parts of the general problem to which this article is devoted. The article discusses the previously unresolved parts of the general problem of developing creative thinking in the process of pharmacological training of future doctors. Particular emphasis is placed on such aspects as the use of creative approaches in pharmacology, where standard teaching methods are mostly focused on memorizing facts and characteristics of medicines. Instead, the article emphasizes the importance of interactive teaching methods that stimulate students' creativity, develop their ability to make non-standard decisions and adapt knowledge to specific situations.

In addition, the issue of using problem-based learning is raised, which is considered as a tool for developing students' analytical and critical thinking, which has not yet been sufficiently studied in the context of pharmacological training. This approach allows students to independently solve complex clinical cases using the acquired knowledge. The article also focuses on the need to integrate innovative educational technologies, such as virtual simulations and multimedia programs, which allow students to experiment with different therapeutic approaches, developing creative thinking.

Presentation of the main material. Creative thinking in modern education and professional training of doctors is defined as the ability to generate new ideas, to take a non-standard approach to problem solving, and to apply knowledge in new, unpredictable conditions. Creativity is important for healthcare professionals because each patient is unique, and the approach to treatment should be individualized.

Pharmacological training is one of the most complex and theoretically rich disciplines in medical education. Teaching pharmacology often focuses on memorizing a large number of drugs, their properties and uses. However, to develop creative thinking, it is necessary to use methods that promote the creative activity of higher education students, such as:

Problem-based learning is a pedagogical approach that aims to develop critical thinking and problem-solving skills through active work with complex situations close to real life. In this approach, higher education students are faced with clinical cases or problems that require the application of their knowledge of pharmacology to solve. It is important that in problem-based learning, students do not receive ready-made answers from teachers, but must look for solutions themselves, working in groups and analyzing different options for the development of the situation [16].

This approach promotes the development of skills in information analysis and synthesis, as higher education students must not only find the right solution to the problem, but also justify their choice, taking into account all aspects of pharmacological therapy. They learn to assess the risks, consequences and effectiveness of various treatments. This approach allows them to apply their theoretical knowledge in practice, preparing them for real clinical situations [9].

Interactive teaching methods are an effective means of developing creative thinking and actively involving higher education students in the learning process. They include such forms as group discussions, clinical case simulations and role-playing games. These methods allow higher education students to feel like a doctor, faced with problems that require quick but informed decisions.

During such classes, students not only repeat the material, but also actively use their knowledge to solve clinical problems, discuss different solutions in groups, and critically evaluate each other's actions. This contributes to the development of communication and teamwork skills, which are key for healthcare professionals [7].

Innovative technologies in education. Modern technologies open up new opportunities for pharmacology education, making it more interactive and practically oriented. The use of virtual simulations, multimedia training programs and online platforms allows higher education students to gain experience as close as possible to real clinical situations.

Virtual simulations, for example, provide an opportunity to model different clinical cases where students can experiment with different treatment strategies, analyze their results and study the possible consequences of their decisions. This allows not only to memorize the material, but also to use creative thinking to solve real problems. Innovative technologies contribute to the development of decision-making skills and help higher education students generate new ideas and approaches in the learning process.

Such technologies also make it possible to adapt the learning process to the individual needs of students, providing them with the opportunity to practice at a time and pace convenient for them [10].

Motivation of higher education students to study plays an important role in the development of creative thinking. Teachers should create conditions where future doctors feel interested in the topic and want to explore new approaches. Stimulating intrinsic motivation, for example, through the use of real clinical cases or scientific research, can significantly increase the level of creativity.

Creativity is developed not only through individual learning but also in teamwork. During group discussions and solving clinical problems, higher education students exchange ideas, generate new approaches to treatment and look for innovative solutions together. Such collective activities allow developing creative thinking skills through interaction with others.

Pharmacology training should not only involve teaching information, but also stimulating critical thinking. For example, analyzing complex cases of adverse drug events can be important for developing the ability to assess risks and predict consequences.

Assignments that require students to create new treatment regimens or modify existing approaches are a powerful stimulus for developing their creativity. Teachers can encourage students to propose non-standard solutions and defend them with reasons [1; 6].

Innovative educational technologies, such as clinical situation simulators, allow higher education students not only to practice their skills but also to formulate creative solutions in conditions as close to real life as possible.

We consider it appropriate to propose the option of conducting a training session on "Creative Approach to Personalized Pharmacotherapy in Patients with Chronic Diseases" as part of our study.

This class aims to teach higher education students to develop individualized treatment regimens for patients with chronic diseases, taking into account their individual characteristics. Students should develop creative thinking skills in the process of pharmacological training, which will help them find non-standard approaches to treatment. Additionally, the class will help to deepen knowledge of pharmacodynamics and pharmacokinetics of drugs in different categories of patients, which is a key aspect for the development of effective therapeutic regimens.

The expected outcomes are that higher education students should learn to conduct individualized assessment of pharmacotherapy for patients with chronic diseases, offer non-standard and personalized approaches to treatment, taking into account pharmacokinetic and pharmacodynamic parameters. They should also be able to defend their proposals with arguments and substantiate them with scientific data.

In the introductory part of the class, higher education students are introduced to topics related to individualization of therapy for patients with chronic diseases such as hypertension, diabetes, and chronic renal failure. During this stage, the teacher provides a brief overview of the pharmacokinetic and pharmacodynamic features of the main groups of drugs used to treat these diseases. Particular attention is paid to the factors that influence the choice of dosage and regimen for each patient, taking into account their individual characteristics.

During the presentation of clinical cases, the instructor provides three different scenarios, each of which presents challenging conditions for choosing personalized therapy. For example, one case involves a patient with hypertension and chronic kidney disease, where standard doses of antihypertensive drugs cause side effects that make treatment difficult. Another case involves a patient with diabetes mellitus and obesity, where the risks of insulin resistance should be taken into account when choosing a therapy. The third clinical case involves an elderly patient with polypharmacy and a high risk of drug interactions, which requires a particularly careful selection of a drug regimen [5; 12].

During the group work, the students are organized into groups of 4–5 people and receive one of the clinical cases. Their task is to analyze the pharmacotherapy, taking into account the

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patient's individual characteristics, such as age, comorbidities, and other medications. After that, each group has to propose a personalized treatment regimen, taking into account the pharmacokinetic and pharmacodynamic characteristics of the drugs. Particular attention is paid to creative solutions, such as modifying the dosage, choosing non-standard drug combinations, or changing the dosage regimen.

During the presentation and discussion of solutions, each group presents its therapeutic approaches, justifying the choice of treatment and explaining why they chose these methods. The discussion includes a detailed assessment of the risks and benefits of the proposed solutions to determine their effectiveness and safety. The discussion also helps to identify new, creative approaches to personalizing treatment that take into account the characteristics of patients. In addition, students work together to identify possible alternative treatment options or scenarios that could be applied in similar clinical cases.

The outcome of the lesson includes a summary of creative and personalized approaches presented by the students during the discussion. The lecturer emphasizes the importance of individualizing pharmacotherapy to improve the effectiveness of chronic disease treatment, which demonstrates the need to take into account the characteristics of each patient. In addition, the students' participation in teamwork, their cooperation skills, and the level of argumentation of the proposed solutions are assessed, which allows us to determine their readiness for real clinical challenges.

Tools for conducting the lesson include several important elements. A whiteboard or interactive panel is used to visualize treatment regimens and visuals, which helps students better understand the process of choosing a therapy. In addition, students receive materials on the pharmacodynamics and pharmacokinetics of the main drugs, which allow them to study their effects on the body in more depth and help them make decisions. Online tools for creating clinical case simulations also play an important role, allowing to recreate realistic clinical scenarios and engage students in interactive learning (figure 1):

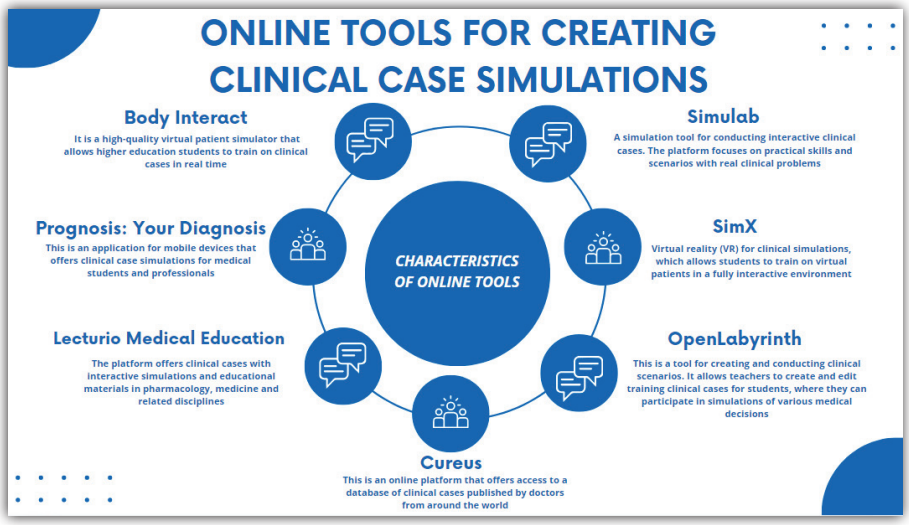

Figure 1. Online tools for creating clinical case simulations

Body Interact. It is a high-quality virtual patient simulator that allows higher education students to train on clinical cases in real time. The program simulates real-life clinical scenarios where users can make decisions, observe results, and receive feedback (figure 2):

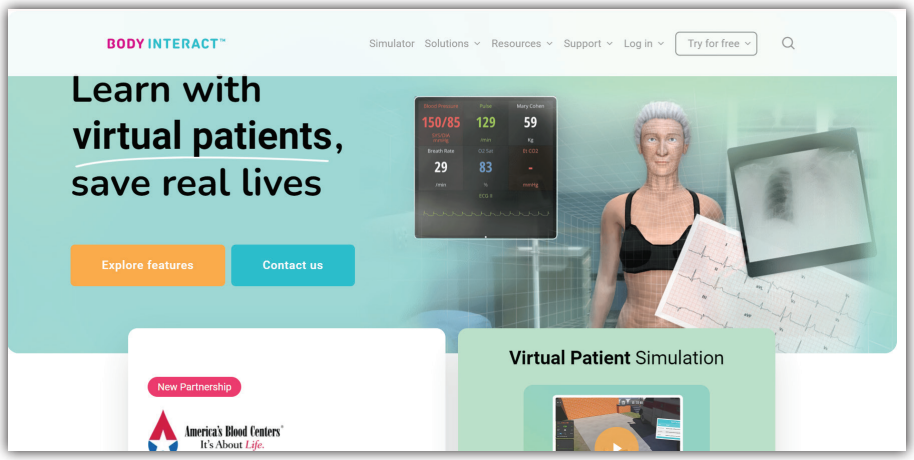

Figure 2. Body Interact website interface

Features of this tool include the ability to customize different medical scenarios, which allows you to adapt the learning process to the needs of both students and professionals. It provides interactive clinical cases in real time, allowing users to practice solving realistic medical problems and receive immediate feedback on their solutions [2].

Prognosis: Your Diagnosis. This is an application for mobile devices that offers clinical case simulations for medical students and professionals. It has more than 150 interactive scenarios that help students learn by solving real-life clinical problems.

Features of this tool include the display of real clinical cases, diagnostic decisions, and treatment plans, allowing students to work with realistic scenarios. It also provides built-in explanations and clinical guidelines to help students better understand the treatment process. In addition, there is an interactive treatment choice option where users can see explanations of the consequences of their decisions, which helps them improve their clinical skills and decision-making [13].

SimX. Virtual reality for clinical simulations, which allows students to train on virtual patients in a fully interactive environment. The tool supports multidisciplinary collaboration between doctors and other healthcare professionals (figure 3):

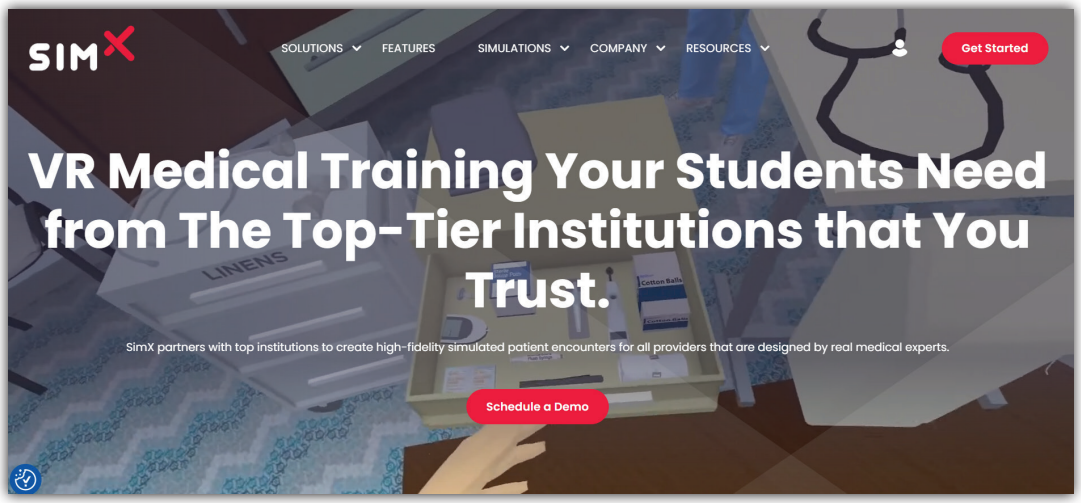

Figure 3. SimX website interface

Features of this tool include support for multiplayer VR for team participation, allowing multiple users to work simultaneously on solving clinical cases as a team. It also provides the ability to customize individual clinical cases to meet specific training needs. Realistic simulations recreate patient care, which helps to develop practical skills and decision-making abilities in conditions as close as possible to real clinical situations [15].

Lecturio Medical Education. The platform offers clinical cases with interactive simulations and educational materials in pharmacology, medicine and related disciplines. Includes interactive clinical case simulations to deepen knowledge.

Features of this tool include an extensive database of pharmacology learning materials, which allows students to study theoretical aspects in depth. The tool also offers interactive clinical simulations that facilitate the practical application of knowledge in realistic settings. In addition, users have access to knowledge tests to help them assess their learning and prepare for exams [8].

Cases Database (Cureus). This is an online platform that offers access to a database of clinical cases published by doctors from around the world. Higher education students can use these cases for analysis and simulations (figure 4):

Figure 4. Cureus website interface

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This tool has the following features: it offers a large database with numerous clinical scenarios, which allows students to gain a variety of experience in solving medical problems. The tool also supports integration into the educational process through the use of clinical tasks, which facilitates its inclusion in curricula. In addition, it provides free access to the database of clinical cases, making it accessible to a wide range of users [4].

OpenLabyrinth. This is a tool for creating and conducting clinical scenarios. It allows teachers to create and edit training clinical cases for students, where they can participate in simulations of various medical decisions (figure 5):

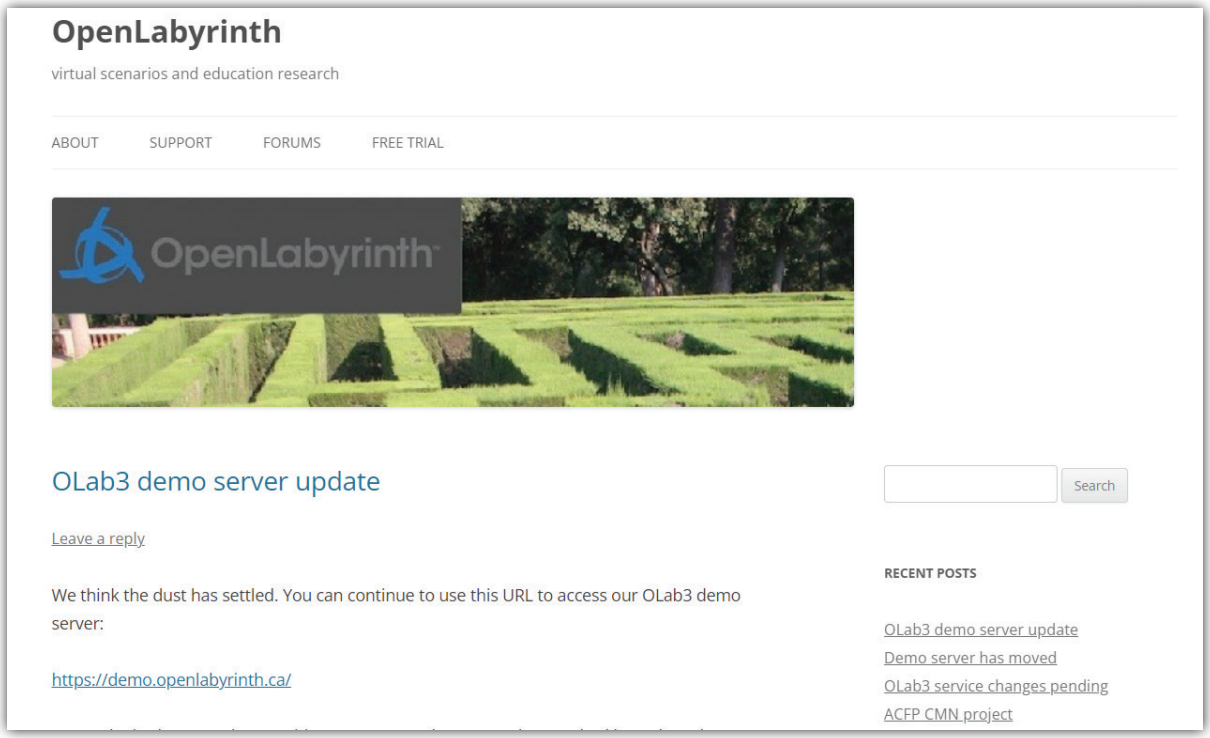

Figure 5. OpenLabyrinth website interface

The features of this tool include the ability to create unique clinical scenarios, which allows you to adapt the learning process to the specific needs of higher education students. Users can customize the scenarios in such a way as to reproduce real clinical situations with varying degrees of complexity, which increases the practical value of training. Additionally, support for multimedia content such as images, videos, and animations provides a deeper immersion in the learning process and improves the perception of information [11].

Simulab. A simulation tool for conducting interactive clinical cases. The platform focuses on practical skills and scenarios with real clinical problems (figure 6):

Figure 6. Simulab website interface

This tool has the following features: it supports the development of practical skills through simulations, which allows higher education students to practice in real clinical situations. It offers a set of realistic clinical scenarios that bring the learning process as close as possible to the conditions of real medical practice [14].

After the lesson, students receive an individual assignment to develop a personalized pharmacotherapy regimen for a complicated clinical case (for example, a patient with polymorbidity) and justify the choice based on pharmacological studies.

The assessment should be based on the following criteria: creativity and validity of the personalized approach to therapy; ability to analyze and synthesize information; quality of teamwork and activity in presenting solutions.

This interactive class is aimed at developing creative thinking, personalizing treatment approaches and deepening knowledge of pharmacology, which will allow higher education students to prepare for real clinical situations in their future practice.

Conclusions. The development of creative thinking of future doctors is an integral part of their professional training, especially in the context of studying pharmacology. In the current conditions of rapid development of medical technologies and pharmaceutical science, the importance of doctors' creative abilities is growing. The use of interactive methods, teamwork, innovative technologies and stimulation of motivation of higher education students are key approaches to developing their creative thinking. This affects not only their ability to make non-standard decisions in their future professional activities, but also the overall level of their medical competence.

Prospects for further exploration. Prospects for further research in the context of the development of creative thinking of future doctors in the process of pharmacological training are to deepen the study and practical implementation of interactive teaching methods and technologies. One of the directions is to further study the effectiveness of problem-based learning, which promotes the development of analytical and critical thinking. In addition, it is promising to expand the use of innovative technologies, such as virtual simulations and multimedia programs, which enable students to develop creative thinking and generate new therapeutic approaches. It is important to study the impact of teamwork and stimulation of intrinsic motivation on the level of development of students' creative potential. Further research could also focus on optimizing individualized approaches to pharmacotherapy through simulations of real clinical cases. This will allow for a more effective integration of theoretical knowledge with practice, which is key to preparing future doctors for real clinical challenges.

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