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### **STEM- education in the chemical training of future pharmacists**

*Annotation* STEM - ducation in the chemical training of future pharmacists  
Abstract. The paper examines the principles of introducing elements of STEM -  
education into the training of pharmacists, and gives examples of their application in  
the study of chemical disciplines in the complex of professional training of  
pharmacist students. It is shown that for students' interest in self-education,  
interdisciplinary and project approaches are used, which demonstrate the integration  
of natural sciences into modern pharmaceutical technologies. Therefore, the use of  
elements of STEM- education in pharmaceutical education contributes to the creation  
of a scientific and methodological base for increasing the professional competence of  
specialists.

Keywords: STEM- education, chemical disciplines, pharmaceutical education.

To train highly qualified pharmaceutical specialists the key trends are the digital  
transformation of the public and state sectors and the transition to a high-tech society,  
automated production, the creation of new business models based on digital  
technologies and fundamental fields of knowledge. In order to ensure the  
modernization of education in accordance with the technological innovations of  
modern society and the challenges of digital transformation, the Cabinet of Ministers  
of Ukraine in 2020 approved the Concept of the Development of Science and

Mathematics Education, the implementation of which in Ukraine is planned for the period until 2027 as a state policy to increase the level of national competitiveness of the economy [1]. The introduction of elements of STEM - education in institutions of higher pharmaceutical education can provide a more thorough natural and scientific training of future pharmacists, who will be able to work in the conditions of high-tech and digital pharmacy, contributing to the formation of a holistic scientific worldview of the individual and the development of high-level thinking skills. According to the educational and professional program of the specialty "Pharmacy, industrial pharmacy", natural and scientific training is a mandatory component, which also includes chemical disciplines (inorganic chemistry, analytical chemistry, physical and colloidal chemistry, physicochemical analysis in the creation of medicinal products). The purpose of our study was to highlight the use of elements of STEM - education when conducting classes in the disciplines of the chemistry unit with pharmacy students.

Chemical disciplines provide interdisciplinary integration links with disciplines that belong to the natural-scientific and professional training of pharmacists and are aimed at familiarizing students with the laws and principles of chemical-information processes in systems of different levels of the health care hierarchy, problems of collection, preservation, processing and transmission of signals and images in pharmacy. Disciplines of the chemical unit relate to decision support systems in pharmacy, analysis of information technologies, mathematical and computer modeling, forecasting, management in the field of medical and biological research, planning and correct conduct of statistical research in practical and experimental pharmacy, as well as the application of medical and pharmaceutical information systems as components of the electronic health care system [2]. To introduce a STEM-oriented approach, we supplemented and modernized the content of chemical disciplines, covering topics related to STEM - knowledge and skills, created online courses on the distance learning platform, for which multimedia educational content was prepared, in particular, an interactive presentation of educational materials, video and audio recordings of theoretical and practical information on topics,

methodological recommendations for independent work of students, means of online control and formal evaluation, methodological recommendations for the implementation and placement of student interdisciplinary projects on the Meet Google platform. To develop STEM - oriented online courses in chemical disciplines, the research and synergistic principles [3] of the modernization of the teaching of natural sciences in institutions of higher medical education were taken [4]. We see the didactic possibilities of the STEM - oriented approach in the teaching of the disciplines of the chemical unit in the development in students of a holistic scientific outlook, innovative thinking, research, analytical, creative skills, the formation of STEM - competence, the implementation of innovative, research and experimental activities through the integration of knowledge from the natural sciences, technologies, engineering and mathematics with a synergistic combination of traditional and innovative teaching methods, implementation of STEM - oriented interdisciplinary projects with planned provision of readiness of future pharmacists to work in conditions of high-tech digital health care and further use of STEM - knowledge and skills in professional activities. The leading component in the implementation of the STEM - oriented approach in the teaching of chemical disciplines in our study was the implementation of original, project-oriented, professional-oriented tasks, which were based on the application of STEM - knowledge and skills and the implementation of STEM - scientific and experimental activities of students, which provides an opportunity for in-depth training, acquisition of skills, creative thinking and holistic natural and scientific training of future pharmacists, using at the same time a powerful toolkit of digital technologies. The introduction of a STEM - oriented approach as a modern and relevant learning paradigm in a high-tech society, in particular, when teaching the disciplines of the chemical unit, has proven its effectiveness, significant didactic opportunities and the creation of conditions for the formation of the latest STEM - competencies of future pharmacists. One of the main tasks for a STEM - teacher is the organization and support of targeted cognitive activities of pharmaceutical students, the formation of abilities, skills of scientific and research activity, the preparation of educational and

teaching-methodical materials containing integrated information of the disciplines of the educational institution, the chemical profile with STEM - technologies. The teachers of the department of biochemistry and medical chemistry encourage students to develop presentations on a relevant topic, to connect their research with life, to show independence, purposefulness, and perseverance in solving the given task. It is important to develop scientific and research abilities of pharmaceutical students, so they participate in various scientific conferences and competitions of scientific student works. An example of such activity was the participation of pharmaceutical students in: the second international symposium "Education and health of the younger generation", 2018; VIII and X All-Ukrainian scientific and technical conferences of students, postgraduates and young scientists "Ecological problems of the regions", Dnipro, 2019, 2020; XX All-Ukrainian conference of young scientists and students on current issues of modern chemistry, Dnipro, 2022. In the process of preparing for conferences, students performed a large amount of search and research work aimed at forming general (informational, multicultural, speech, social) and professional (ability to collect, register and analyze data of medical, biological, chemical research using appropriate methods and technological means, the ability to evaluate and interpret the obtained results) competencies. Students go from the birth of an idea to its practical implementation and presentation in the form of a presentation. During the search process, students develop the ability to think and use the principles of metasubjectivity. Thanks to this, the principles of STEM - education are implemented, which combines interdisciplinary and project-based approaches, the basis of which is the integration of natural sciences with technology, engineering skills and mathematics. By creating their reports on the basis of the conducted research, pharmacist students lay the seeds of future professional competences, namely the ability to pose a problem, find connections between the problem and all possible disciplines, formulate a research direction and think of ways. solve it, formulate and defend one's own point of view on the existing problem; the ability to analyze and synthesize. Using interdisciplinary connections, we increase the effectiveness of chemical education of pharmacy students. When studying any

section of the disciplines of the chemical unit, the teacher builds integration links with other general theoretical and pharmaceutical disciplines. For example, when studying the section of physical and colloidal chemistry "Buffer systems", the concepts of alkalosis and acidosis begin to form in the course of inorganic chemistry (1st course), then they are consolidated and developed during the study of physical and colloidal chemistry (2nd course), analytical chemistry (2nd course), biochemistry, normal and pathological physiology (3rd year) and further when studying pharmaceutical disciplines (pharmaceutical chemistry, pharmacology, etc. - 4-5 courses), and then - in professional activity. The inclusion of sections such as "Surface Phenomena", "Dispersed Systems", "Redox Processes and Equilibria" in the content of chemical disciplines will contribute to the understanding of the methods of obtaining medicinal products in the form of suspensions, the emergence of bioelectric potentials, heart rhythm disturbances. Equally important and professionally oriented in the structure of chemical disciplines is the section "Teaching about solutions", when mastering which students can: carry out calculations necessary for the preparation of perfusion solutions, calculate the value of the hydrogen index, predict such processes as plasmolysis, hemolysis, acidosis, alkalosis, to understand the processes occurring during the operation of the "Artificial Kidney" apparatus, as well as to simulate biochemical processes.

Study guide and two methodical guides for preparation for "Step-1. Pharmacy" for domestic students and translated into French and English for foreign students, created by the teachers of the department over the past two years, are aimed not only at generalization and accessibility of the material of chemical courses, but also at revealing all kinds of interdisciplinary connections. Printed textbooks meet the requirements of STEM - education and act as an effective means of integrated training of pharmaceutical students, which will contribute to the formation of natural-scientific and research competence of students and their creative abilities. The traditional formulation of the general goals of textbooks is that during a certain period of study the student will gain new knowledge, answer the question: what knowledge, skills, abilities and skills will the student acquire by using its content. The final result

of a high-quality textbook on the disciplines of the chemical unit will be evidenced by the level of acquired knowledge, formed abilities, skills, as well as the development of personal qualities that are recognized as leading both in the past and in the conditions of updated standardized education. Given this, the difference lies in the choice of ways, methods and conditions for improving education through the introduction of STEM - education. The content of the textbooks contains a sufficient amount of variable material for carrying out different forms of work (independent, group and individual), which indicates its multifunctional role and is designed to help students not only in learning knowledge, possessing information, but also in improving their research skills, forming innovative thinking, which is the main goal of STEM - education.

Therefore, the modernization of higher pharmaceutical education in Ukraine is inextricably linked with the development of the entire society, the characteristic features of which at the present stage are the renewal of the structure and content of education, as well as the renewal of the main means of education - textbooks.

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