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### **Methods of implementation of STEM education ideas in chemistry textbooks**

*Abstract.* The paper analyzes the role of textbooks in chemical disciplines as a means of integrating knowledge in the disciplines of the chemical cycle and forming scientific thinking and research skills of students with the aim of introducing STEM education in universities; the expediency of implementing in textbooks various forms of work, in particular research activities, by applying the project method, which will encourage students to identify intellectual and creative abilities, moral and communicative qualities and contribute to the formation of creative thinking, abilities, skills to creatively use acquired knowledge and create innovations, is substantiated .

*Keywords:* *STEM education, knowledge integration, research skills*

STEM-education is a series or sequence of courses or programs of study that prepare pharmacy students for successful employment by requiring different and more technically complex skills, including the application of mathematical knowledge and scientific concepts. Such an education system teaches to live in a real fast-changing world, to be able to respond to changes, to think critically and to be a developed creative personality [1-2]. Textbooks on chemical disciplines (Methodological guide for preparing students for "Step-1. Pharmacy" in the discipline "Analytical Chemistry" and Methodical guide for students to prepare for "Step-1. Pharmacy" from the discipline "Physical and colloidal chemistry, authors of

chemistry", G.S. Maslak, L.I. Khmelnikov) provide for 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 - to provide students with new knowledge during a certain period of study - does not fully meet the requirements of state education standards. In the new conditions, a modern textbook on chemical disciplines should answer the question: what knowledge, abilities, skills and competencies will the student acquire by using its content. The final result of a high-quality textbook on chemical disciplines 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. In view of this, the difference lies in the choice of ways, methods and conditions for improving education through the introduction of STEM-education, which forms educational qualities, value orientations, scientific research skills and competences that develop into the student experience. is formed These tasks must be solved by using complex and creative approaches, scientific research methods and teaching methods in teaching chemical disciplines, since it is in this direction that there are real opportunities to involve students in project and research activities, as in practical classes. and after-hours. Research activity is connected with the discovery of new knowledge, new personal opportunities of students, which will contribute to the formation of a positive self-esteem of the student, will generate self-confidence and a sense of satisfaction from the achieved successes, as well as how to develop their creative abilities and create quality prerequisites for increasing the interest of students in learning material And they will also contribute to the upbringing of a vitally and socially competent individual, capable of independent choice and making responsible decisions in various life situations, the development of the ability to integrate and creatively use the acquired knowledge. After all, nowadays these skills are a social value and it is not a secret for anyone that nowadays a person's competitiveness in the

labor market largely depends on his ability to think creatively, master new technologies, adapt to changing working conditions and create innovations.

The analysis of the latest research and publications proved that the problems of creating textbooks from the specified chemical disciplines, which should integrate the educational material and form a comprehensively developed personality, form the research skills of future pharmacists during the implementation of the projects presented in the textbooks. , were not considered, which led to the consideration of this problem. The purpose of the work is to reveal the role of textbooks in chemical disciplines (analytical chemistry and physical and colloidal chemistry) in the integration of knowledge and the formation of research skills of pharmaceutical students during the implementation of projects, as a condition for the implementation of STEM-education. In accordance with the set goal, the task was set - to theoretically substantiate the value of the project method in the formation of students' research skills in the process of integrating knowledge from the disciplines of the chemical cycle. Developing, each science not only deepens knowledge about the natural and scientific picture of the world, but also expands the boundaries of its research. Therefore, the textbooks reveal the role of integrating the disciplines of the chemical cycle to obtain comprehensive knowledge about the natural and scientific picture of the world, their understanding and application in the implementation of selected projects [1]. Modern chemistry textbooks must meet the requirements of the time and perform multifaceted functions, which means not only the assimilation of knowledge, but also the acquisition of the skills of integration, systematization and self-control, promotion of the practical use of acquired knowledge and the formation of creative thinking, promotion of the formation of creative thinking, promotion of the formation of skills and skills . research skills and creative abilities of students, and also provides STEM education. Therefore, in the textbooks, we pay special attention to the definition of appropriate methods, forms and means of education that integrate knowledge from chemical disciplines, as well as the formation of integral knowledge of chemistry in students based on the general laws of chemistry, which should be embodied in the methodological apparatus of textbooks. The content of the

textbooks contains a sufficient volume of variable material for carrying out different forms of work: independent, group and individual, which indicates their multifunctional role.

The function of self-education is designed to form the desire and ability of students to independently acquire knowledge, eliminate gaps, stimulate motivation and the need for self-knowledge and self-development, and the formation of a life-affirming image of the world. , which determines the quality of education. According to the evaluation methods developed in global practice, the quality of education appears not as a total expression of knowledge and skills from the subjects of the curriculum, but as an integral indicator of all stages of personality formation, which includes not only the results of the educational process in comparison with the standards, tasks in the standards, but also as well as the student's life and educational experience, conditions and features of the learning and upbringing process [2]. The experimental curriculum of the integrated course involves the implementation of project activities in the educational process. After each topic, we provide a list of project topics that the teacher of the department offers students to implement. For example, we offer students the following projects: 1) the relationship between chemistry, the state of the environment and human health; 2) the impact of negative changes due to chemical processes in the environment on living organisms; 3) the main human diseases caused by adverse chemical factors of the external environment. The project activity is aimed at the acquisition of knowledge by students in close connection with the practice of real life, the formation of scientific and research abilities and skills in them thanks to the systematic organization of problem-oriented educational research. Currently, the project method is widely used in the practice of education provided by STEM-education, with the aim of developing students' cognitive skills and creative abilities and mastering the skills of working with computer technical means of learning orientation in the information space. Tasks aimed at integrating chemical knowledge in the process of forming scientific and research skills of future pharmacists are planned in the textbooks. And the task of the teacher, in turn, is the gradual and thorough formation of research skills, the

implementation of constant control over the performance of research works (projects) by students; analysis and correction of errors; determining the best, most effective ways of doing work, as well as finding out the possibilities of further application of the obtained results, that is, the teacher must be ready to implement the basic provisions of STEM-education. From the experience of implementing integrated courses, it can be argued that the use of project activities in laboratory-practical classes in chemistry is one of the effective scientific and research methods in the educational process, which will contribute to the formation of students' interest in cognitive and creative activities, creative self-development and self-realization [3] , the formation of new cognitive values, abilities, skills and a research position in the perception and understanding of chemistry, its regularities, mastery of chemical-scientific competence. , which includes: a) assimilation, integration of natural and scientific knowledge based on the general laws of chemistry and their use in the development of educational new cognitive tasks; b) development of responsibility for the state of the environment, the ability to correlate one's own behavior in the environment with morals and legal norms in society; c) the ability to analyze, synthesize, compare, generalize natural phenomena and objects; d) the ability to apply general laws of nature to explain phenomena and objects. Educational design is primarily focused on the independent activity of students - individual, pair or group, which students perform at a certain time. Design technology involves the solution of any problem by a student or a group of students, which involves, on the one hand, the use of various methods and means of learning, and on the other hand, the integration of knowledge and skills from various fields of science, technology, and creativity [4]. Project activity really demonstrates the broad possibilities of cooperation, during which students set a goal, determine the optimal means of achieving it, draw up a project implementation plan, distribute tasks and responsibilities, offer forms of presentations of their own projects; demonstrate own competence. Thus, the essence of project-research activity is to stimulate students' interest in certain problems that involve the solution of one or a whole series of problems, to show the practical application of acquired knowledge. As experience shows, the project, as a fairly new

type of research activity, encourages students to discover intellectual abilities, moral and communicative qualities, demonstrates the level of mastery of chemical knowledge and general academic skills. In the process of implementing the project, students gain new knowledge and practical skills, integrate educational information of related disciplines, and look for more effective ways to solve the tasks set in the project. The result of the introduction of a new type of scientific research activity is participation in various scientific conferences, 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.

Thus, textbooks on chemical disciplines for pharmacy students, as the most important means of learning, have a wide range of interdisciplinary connections and opportunities for their practical application and are designed to help students not only in learning knowledge, possessing information, but also in improving knowledge, their research skills and the formation of innovative thinking, new cognitive values, which are the basis of the student's intellectual growth and the formation of his creative personality, which is the main goal of STE- education.

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