СУЧАСНА ПЕДАГОГІЧНА ОСВІТА: ПРОБЛЕМИ ТА ПЕРСПЕКТИВИ

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USING THE PROJECT METHOD IN THE STUDY OF ORGANIC CHEMISTRY

Marianna Barus[1], Yuliia Diuzhykova[1], Olga Skrypska[2], Tetiana Chetvertak[1]

Bogdan Khmelnitsky Melitopol State Pedagogical University1
Yuriy Fedkovych Chernivtsi National University2

Resume:
The article examines the theoretical and methodological aspects of applying the project method in the study of organic chemistry in secondary schools. The relevance of introducing project-based learning as an effective means of developing pupils' cognitive activity, research skills, and key competencies is substantiated. The stages of project implementation are defined; examples of project topics and forms of work organization are provided. The results of the project-based approach show an increase in pupils' motivation, improved academic performance, and the development of independent learning skills. The study concludes that the use of the project method in teaching organic chemistry is appropriate for deepening knowledge and forming pupil's scientific worldview.

Key words:
organic chemistry; project method; competency-based approach; educational process; research activity; motivation.

Анотація:
Барус Маріанна, Дюжикова Юлія, Скрипська Ольга, Четвертак Тетяна. Використання методу проєктів у вивченні органічної хімії. У статті розглянуто теоретичні та методичні аспекти застосування методу проєктів у процесі вивчення органічної хімії в закладах загальної середньої освіти. Обґрунтовано актуальність упровадження проєктної технології, як одного з ефективних засобів формування пізнавальної активності, дослідницьких умінь та ключових компетентностей учнів. Визначено етапи реалізації методу проєктів, подано приклади тем навчальних проєктів і форми організації роботи. Описано результати впровадження проєктної діяльності, які свідчать про підвищення мотивації учнів, покращення навчальних досягнень і розвиток навичок самостійної роботи. Зроблено висновок про доцільність використання методу проєктів для поглиблення знань з органічної хімії та формування наукового світогляду школярів.

Ключові слова:
органічна хімія; метод проєктів; компетентнісний підхід; навчальний процес; дослідницька діяльність; мотивація.

Statement of the problem. The modern education system is focused on the formation of a competent, creative personality, capable of independently acquiring and applying knowledge. In this context, innovative pedagogical technologies that ensure the active participation of pupils in the educational process are of importance. One of the most effective methods is the project method, which combines theoretical knowledge acquisition with practical, research and creative activities.

The relevance of using the project method in teaching chemistry is determined by the need to form in pupils not only subject knowledge, but also the ability to research, analyze, draw conclusions, and present the results of their work. This is especially important when studying organic chemistry, since this section often causes difficulties for pupils due to the abstractness of concepts, the complexity of structural formulas, and the need to memorize a large amount of factual material.

Analysis of recent research and publications. The concept of the project method was developed in the early 1920s in the USA. The word «project» comes from Latin and means «forward-looking», while the term «project method» is translated from Greek as «path» or «method of research». The beginning of project pedagogy is associated with the humanistic direction in the philosophy of education, which was embodied in the pragmatic pedagogy of John Dewey. It was based on the idea of gaining knowledge and experience through solving practical problems. At the same time, the only criterion for the value of an educational subject was considered to be its contribution to the formation of the pupils' internal personal orientation. This approach was further developed in the project method, proposed by William Kilpatrick in 1918. The essence of the method was that pupils had to solve a certain problem independently or in a group, using knowledge from various sources, and obtain a specific, tangible result. The ideas of project-based learning have been the focus of attention of many foreign scholars, including J. Eyring, A.G. Papandreou, and others. It is worth noting that this method is widely used not only in the USA but also in such countries as England, Belgium, and Ukraine (Kilpatrick, 1918, p. 319-334).

In recent years, the popularity of project technology in Ukraine has grown significantly. (Avdeeva, 2019, p. 65-69). Many works have been devoted to the study of project activities (Zagnibida, 2011, p. 28-61; Voronenko, 2016, p. 76-91; Voronenko, 2018, p. 34; Shiyan, 2023, p. 143; Budzhak, 2004, p. 43-45, Logvin, 2002, p. 12-14). Project technology is considered as one of the

interactive teaching methods. The essence of the technology is that the educational project is created with constant, active cooperation of all pupils and the teacher. Moreover, both pupils and teachers are equal subjects of learning. According to N. M. Zagnibida, the project methodology is one of the most effective means of forming and developing pupils' life competencies. She emphasizes that it is this approach that contributes to the awakening of natural curiosity and the development of creative abilities (Zagnibida, 2011, p. 28-61). The project method is a learning system in which pupils acquire knowledge and skills in the process of independently completing a complex task – a project that has a practical or research focus. This approach corresponds to the competency-based approach, as it contributes to the formation of subject, research, information, communication and social competencies (Logvin, 2002, p. 12-14). In the article (Voronenko, 2016, p. 76-91) the historical development of pupils' project activities in pedagogical practice in different countries was analyzed, a modern classification of educational projects was presented, and their place in the methodology of teaching chemistry in secondary education institutions of Ukraine was determined. Special attention was paid to the methods of implementing competency-based, activity-based and personality-oriented approaches during the implementation of pupils' educational projects. In the teaching and methodological manual (Shiyan, 2023 p. 143) recommendations are provided for the implementation of projects, which include the main requirements, stages, and algorithm for project implementation, as well as examples of project passports in chemistry that were presented during the «Festival of Pupils and Their Projects in Chemistry», which took place on April 26, 2024.

Formulation of the article's objectives. The purpose of the article is to substantiate the effectiveness of the project method in the process of studying organic chemistry and to determine the pedagogical conditions that ensure the successful implementation of this method in the educational process.

To achieve the set goal, the following tasks are planned to be solved:

- analyze the theoretical foundations of the project method and its role in teaching natural sciences;
- reveal the features of organizing project activities when studying organic chemistry;
- give examples of the effective use of the project method in lessons and in extracurricular work;
- assess the impact of this method on the level of academic achievement and the development of key competencies of pupils.

Presentation of the main research material. Recently, the project method has been increasingly used in school practice. The project method is a teaching procedure, an accessible model in the educational process, which is focused on the pupils' realization. Volitional qualities, creative abilities and intellectual capabilities are developed in the process of implementing the project under the supervision of a teacher.

«I know why I need everything I learn and where it is appropriate to apply it» is the main thesis of the definition of project methods, which is of interest to educational systems that are looking for a balance between pragmatic skills and academic knowledge.

The project method is focused on:

- formation and development of cognitive abilities and skills of pupils;
- formation of the ability to navigate in the information space;
- development of the ability to pose a problem and independently construct one's knowledge;
- the opportunity to use one's knowledge from other fields;
- development of motives for learning and self-education;
- formation of a sense of responsibility for the decision made;
- development of communicative abilities and skills;
- ability to think critically (Zagnibida, 2011, p. 28-61).

When creating projects, many problems arise, the solution of which requires integrated knowledge and research. The results of the planned activity should have theoretical and practical, cognitive significance. Independence is the main component of the method. Project activity opens up a wide field of new activities for the pupils, thereby contributing to the emergence of a wide range of interests, and then, through them, influences the formation of beliefs and worldview of the individual (Funtikov, 2003, p. 17-24).

The teacher must use research and search methods. He/she must also skillfully organize discussions without oppressing pupils with his/her authority and without imposing his/her point of view. Special attention must be paid to the emergence of interest in design; it is necessary to ensure that pupils bring their ideas to a logical conclusion (Budzhak, 2004, p. 43-45).

Mastering the methodology of design technology by pupils is the goal of organizing design and technological activities.

Let's pay attention to the main requirements for design technology:

- the presence of a significant research or creative problem (task), the solution of which requires integrated knowledge and search;
- practical, theoretical, and cognitive value of the expected results;
- independent completion of tasks by pupils – individually, in pairs, or in groups;
- clear definition of the ultimate goal of the project;
- logical structuring of the project content with an indication of the stages of work and intermediate results.

Application of research methods, which involves:

- formulation of the problem and objectives of the research;
- putting forward a hypothesis and discussing ways to test it;
- working with scientific sources;
- choosing a justified research methodology (observation, experiment, statistical methods, etc.);
- conducting research, collecting, systematizing, and analyzing the data obtained;
- formatting and presenting the results;
- summing up, correcting the work, formulating conclusions;
- using interactive methods of cooperation («brainstorming», «round table», creative reports, reviews);
- identifying new problems and directions for further research (Shiyan, 2023, p. 143; Khomenko, 2011, p. 374-376).

The possibility of tasks that have several correct answers, and not just one, is a feature of project technology. There is no example for pupils, the so-called standard, which could be looked at, which forces pupils to solve the problem using an arbitrary solution. Therefore, from the perspective of the methodology, it is necessary to reconsider the issue of pupils' creative and mental activity. Using new knowledge, the child will have the opportunity to create broader cognitive opportunities, since project technology contributes to the theoretical generalization of pupils' mental activity (Yaschuk, 2002, p. 298-304).

All of the above proves that it is impossible to doubt the usefulness of project activities. Pupils acquire communicative skills and abilities, perform work in groups, and learn different methods of solving one problem. The principle of ease is not violated; this is one of the most valuable incentives for activity. The more pupils delve into the work, the more they are fascinated by it. Children observe the results of their work and the work of their classmates on their own experience.

In addition to the requirements for project technology, there are a number of requirements for the teacher who conducts it, namely, the ability to use project technology is an indicator of the teacher's high professionalism and orientation on the personal and professional development of the pupils in the process of implementation.

The teacher performs the following functions during project activities:

- helps to find the necessary sources;
- corrects and prompts the entire work process;
- encourages and supports children.

Another important component is the ability to help pupils without doing the work for them. Knowing only their subject is not enough for teachers; they must also be competent in other fields of science. A teacher needs to know their pupils well – their interests, desires, and capabilities. For project organizations, psychological literacy and competence are important for a teacher. A teacher needs to be tolerant, empathetic, and communicative, especially when organizing scientific and international projects. The teacher's creativity, creative potential, and experience in teaching are also noted. The profession of a teacher is one of the most creative professions. Possession of pedagogical psychology will be a plus in a teacher's pedagogical skills, because knowing only their subject is not enough to work on projects. The teacher's individuality always has a bright impact on pupils.

Starting from the junior grades, pupils need to be prepared to work with projects. Pupils independently learn to make their own decisions, form results, and summarize. Project works are defended publicly in the classroom. In this way, pupils overcome their fear of public speaking. The teacher calmly and courageously responds to all of the children's statements, encourages research, awakens curiosity, and develops interest throughout the learning process.

The following stages are distinguished in working on an educational project*:*

1. Preparatory. We determine the topic and objectives of the project. Pupils discuss the subject of the project with the teacher and receive additional information if necessary. At the preparatory stage of the work, the teacher describes the project method, introduces the content of a specific project, and helps pupils determine the goal and objectives of the scientific work.

An object or research problem can become the topic of a scientific project.

An object is the subject of the project, which the pupils choose independently. The teacher encourages the mental ability of the participants in scientific projects.

Research – the selected object must be investigated in the chosen direction.

Teachers determine the question: what exactly do they want to learn about this object?

This question indicates the next sequence of pupils' activities. All work is of a research and cognitive nature.

The problem is noted from the selected object or situation with which it is connected.

It is necessary to investigate whether the project participants are all satisfied, whether nothing bothers them, and whether they would like to improve something.

The theme indicates the essence of further activity: problem – essence – aspects of the problem – methods of solution.

All work is creative and organizational in nature. The next step in the preparatory stage is to specify the goal and objectives of the scientific project.

The final result should be the goal of the project. Having chosen the theme of the project, pupils formulate key, thematic, and content questions, with the help of which they determine the goal and objectives of the project (Stadnik, 2025).

2. Planning. The teacher helps in developing a work plan, selects the necessary information to guide the pupils work, introduces them to sources of information and methods of its collection and analysis, discusses with the pupils the form of the report, establishes criteria for evaluating the result, distributes tasks among the team members. The pupils develop an action plan.

3. Research. At this stage, pupils collect information, systematize it, and solve intermediate tasks, using such research methods as questionnaires, interviews, surveys, and observations. Pupils carry out research, solving intermediate tasks. The teacher observes, advises, and directs the activity. The teacher draws up a schedule of consultations, at which he considers the results of the next stage of work on the project in a draft version and corrects if necessary (Zagnibida, 2011, p. 28-61).

4. Results**.** Report preparation. We analyze information, formulate conclusions, and develop possible forms of presenting results (oral report, demonstration, written report). Pupils analyze, report, and discuss. The teacher acts as an ordinary participant and asks appropriate questions during the presentation. Defense and discussion of scientific projects takes place in a specially designated lesson.

5. Process performance assessment. Through collective discussion, pupils evaluate the work done, and evaluate the results of their own and collective work. The teacher summarizes the results of the educational project, determines the degree of activity of pupils, and evaluates the work of pupils, the quality of the use of sources. The teacher draws pupils' attention to unused resources and directs pupils to continue working on the project. (Shiyan, 2023, p. 143).

This stage of the project is taking place according to this plan:

- project presentation;
- project defense;
- project evaluation criteria;
- announcement of project results;
- project implementation.

Before presenting the work, materials for presentation and discussion are prepared, and assessment criteria are provided. After that, pupils present and defend their work, and the teacher and other pupils evaluate the project and presentation.

The project evaluation criteria are: (Stadnik, 2025):

- relevance and importance of the topic;
- significance of the project topic;
- completeness of research and disclosure of the topic;
- originality of the proposed solutions;
- quality of the practical product.

The project technology uses the technique of «hidden coordination.» This is a method of organizing the work of participants when the teacher secretly manages the work of pupils, prompts, and recommends methods for solving the problem.

The article by T. I. Voronenko presents a modern classification of educational projects. (Voronenko, 2016, p. 76–91).

By the nature of the activity, projects are divided into:

- research (aimed at finding and analyzing new facts and patterns);
- creative (creating new ideas, models, presentations, and video projects);
- informational (collecting, systematizing, and presenting information on a specific topic);
- game projects – pupils choose interesting roles, determined by the content and purpose of the project;
- practice-oriented (developing specific recommendations or products that are useful for the school or community).

Let's consider a few more options for classifying projects, namely:

- by content – chemical, ecological, chemical-biological, physical-geographical, socio-economic, complex, local history, etc.;
- by level of integration – mono-subject (based on knowledge of one subject, for example, chemistry), interdisciplinary (takes into account the content of several subjects on related topics, for example, chemistry and biology or chemistry and literature), extra-subject (carried out on the basis of information that is not included in the school curriculum);
- by duration of project implementation**:** mini-project (several weeks), medium-term (several months), long-term (during the year);

- by number of project participants**:** individual, group, collective;
- by use of teaching aids – classical traditional teaching aids (printed, visual, and technical), information and communication (computer) aids;
- by the forms of presentation of the results of the work – written work, oral report, graphic work (presentation, poster, film);
- by the presence of educational projects in the curriculum – current (project activities constitute part of the volume of educational material), and final (based on the results of the project, pupils' mastery of certain educational material is assessed) (Gritsai, 2012, p. 62-69, Voronenko, 2016, p. 76-91).

The project method has many advantages in teaching chemistry:

- promotes meaningful assimilation of theoretical material;
- forms skills of research and experimental activity;
- develops logical, critical, and creative thinking;
- stimulates interdisciplinary connections (with biology, ecology, physics, and technology) (State standard of primary education, 2019).

Using this method when studying organic chemistry creates conditions for the active involvement of pupils in learning, increases motivation, and makes it possible to implement the principle of «learning through activity» (Macylyuk, 2025, p. 187-190).

Organic chemistry is one of the most difficult sections of the school course, as it requires not only memorizing a large number of facts but also understanding the regularities of the structure, properties, and reactions of organic compounds. Pupils need to operate with structural formulas, spatial models of molecules, rules of nomenclature, and laws of isomerism, which requires developed abstract thinking. For effective mastering of organic chemistry topics, it is important to create conditions under which the pupils do not just receive information but independently discover knowledge through activity.

That is why the project method is an appropriate tool in the study of organic chemistry. It allows you to connect chemical concepts with real-life situations, reveal the practical significance of organic compounds, and show interdisciplinary connections with biology, ecology, medicine, and food technology (Martynets, 2015, p. 10-13).

The implementation of the project method takes place in several stages: choosing a topic, setting a goal, planning, implementation, presentation, and evaluation.

Topics for research most often chosen by pupils:

- detection of phenol in green tea extract or gouache;
- carbohydrates in food products: detection and biological significance;
- ethers and esters in cosmetics;
- removal of organic stains;
- manufacturing products from plastic bottles;
- feasibility and harmfulness of biologically active additives;
- study of the composition and properties of organic substances in everyday life.

The teacher prepared the goal, and objectives, developed a plan for the implementation of individual projects, and determined the expected results of the implementation of the projects (New Ukrainian School, 2016).

Algorithm for implementing the project method:

- choosing a project topic: the teacher can offer a list of indicative topics or allow pupils to independently choose a topic that interests them. It is important that the topic has practical significance and corresponds to the program material;
- formulating the goal and objectives of the project; together with the teacher, pupils determine what problem they are investigating, what they are trying to prove or create, and what methods they will use (experiment, questionnaire, modeling, information search, etc.);
- planning and distribution of responsibilities: at this stage, groups are created (if the work is collective), the roles of participants are determined, a calendar is drawn up, a list of necessary materials is drawn up, and the structure of the report or presentation is formed;
- project implementation: pupils carry out practical and research activities – conduct experiments, observations, analyze results, draw conclusions – the teacher acts as a consultant, adjusts the direction of the research, if necessary, and helps with technical or theoretical issues;
- presentation of results – the form of presentation can be different: oral report, poster, multimedia presentation, video clip, or booklet, research work. This stage forms in pupils the ability to clearly and reasonably express their own opinion;
- evaluation and reflection – not only are the results evaluated, but also the process of work: independence, creativity, ability to cooperate, logical conclusions, and design of materials.

After completing the work, it is advisable to conduct a self-assessment and discuss the difficulties that arose during the project (Cymbal, 2006, p. 4-6).

Examples of successful project implementation.

The experience of implementing the project method in the school course of organic chemistry shows that pupils who participated in project activities demonstrate higher cognitive activity and better understanding of the material. For example, within the framework of the educational and research project «Carbohydrates in food products: detection and biological significance», pupils studied product labels, determined the presence of preservatives and dyes, and analyzed their chemical nature and biological significance for the human body. Such tasks form not only subject knowledge in schoolchildren but also environmental and social responsibility. Pupils learned about the role of carbohydrates in human nutrition and learned to present the results of their own work (Kremen, 2003, 296 p.).

When implementing the practically oriented project «Ethers and esters in cosmetics», pupils not only deepened their knowledge of the general formulas and names of ethers and esters but also learned about the positive and negative aspects of the use of ethers and esters in cosmetics, the chemical composition of some cosmetics, and identified hazardous substances in creams. Working on the project contributed to the formation of pupils' ability to independently search for information using various sources, the ability to speak in front of an audience, the ability to use the acquired knowledge in practical activities and everyday life to choose body care creams, the ability to briefly formulate their opinion, and the ability to select the most vivid, convincing facts to argue their opinions (Zabrodska, 2007).

During the research and practical project «Removing stains of organic origin», the participants investigated the nature of organic stains (fat, protein, dye, etc.), identified effective chemical methods for removing them from various fabrics and surfaces, compared the effectiveness of different stain removal methods, acquired skills in the safe handling of household chemicals, and developed a memo «How to remove stains using chemistry».

The goal of the creative, research, ecological, and technological project «Making products from plastic bottles» was to form environmental awareness and practical skills in reusing plastic waste through the creation of useful products from plastic bottles. All the project tasks were implemented, and practical products from plastic bottles were created that can be used in everyday life. The participants learned about the advantages and disadvantages of plastic bottles, environmental problems associated with plastic bottles, the directions for using unnecessary plastic bottles, and how to turn waste into income. The pupils learned how to give a second life to plastic and create decorative things. After the implementation of the project activity, an increase in interest in organic chemistry, improved learning outcomes, and the development of research competencies were noted. Pupils demonstrate a more conscious attitude towards chemical processes and their connections with life.

Conclusions. The project method is an effective means of forming pupils' cognitive activity during the study of organic chemistry.

In particular:

- increases motivation;
- develops critical thinking;
- provides a practical orientation of learning;
- contributes to the development of key competencies.

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Information about the authors:
Barus Marianna Marynivna
marianna.barus@mspu.edu.ua
Bogdan Khmelnitsky Melitopol State Pedagogical University
Scientific Town, Street 59, Zaporizhzhia, Zaporizhzhia region, 69000, Ukraine

Відомості про авторів:
Барус Маріанна Маринівна
marianna.barus@mspu.edu.ua
Мелітопольський державний педагогічний університет імені Богдана Хмельницького
Наукове Містечко, вулиця, 59, Запоріжжя, Запорізька обл., 69000, Україна

Diuzhykova Yuliia Yuriivna
yulia.diuzhikova18@gmail.com
Bogdan Khmelnitsky Melitopol State
Pedagogical University
Scientific Town, Street 59, Zaporizhzhia,
Zaporizhzhia region, 69000, Ukraine

Skrypska Olga Vasylivna
o.skrypska@chnu.edu.ua
Yuriy Fedkovych Chernivtsi
National University
Kotsiubynsky Street, 2
Chernivtsi, Chernivtsi region, 58002, Ukraine

Chetvertak Tetiana Yuriivna
shafranskaja@ukr.net
Bogdan Khmelnitsky Melitopol State
Pedagogical University
Scientific Town, Street 59, Zaporizhzhia,
Zaporizhzhia region, 69000, Ukraine

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Дюжикова Юлія Юріївна
yulia.diuzhikova18@gmail.com
Мелітопольський державний педагогічний
університет імені Богдана Хмельницького
Наукове Містечко, вулиця, 59, Запоріжжя,
Запорізька обл., 69000, Україна

Скрипська Ольга Василівна
o.skrypska@chnu.edu.ua
Чернівецький національний університет
імені Юрія Федьковича
Коцюбинського, вулиця, 2
Чернівці, Чернівецька обл., 58002, Україна

Четвертак Тетяна Юріївна
shafranskaja@ukr.net
Мелітопольський державний педагогічний
університет імені Богдана Хмельницького
Наукове Містечко, вулиця, 59, Запоріжжя,
Запорізька обл., 69000, Україна

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