ORGANIZING INDEPENDENT RESEARCH ACTIVITIES IN CHEMISTRY OUTSIDE THE LESSON

Kosnazarov Salamat Tanirbergenovich – *Senior teacher*
k.salamat@gmail.com
Nukus State Pedagogical Institute named after Ajiniyaz

KIMYO FANIDAN DARSDAN TAShQARI MUSTAQIL TADQIQOT IShLARINI TAShKIL ETISh

Kosnazarov Salamat Tanirbergenovich – *katta o‘qituvchi*
Ajiniyoz nomidagi Nukus davlat pedagogika instituti

ОРГАНИЗАЦИЯ ВНЕУЧЕБНОЙ САМОСТОЯТЕЛЬНОЙ ИССЛЕДОВАТЕЛЬСКОЙ РАБОТЫ ПО ХИМИИ

Косназаров Саламат Танирбергенович – *старший преподаватель*
Нукусский государственный педагогический институт имени Ажинияза

Tayanch so‘zlar: mustaqil tadqiqot faoliyati, kimyo fanida darsdan tashqari ta’lim, sinfdan tashqari ilmiy izlanish, o‘quvchiga yo‘naltirilgan ta’lim, mustaqil o‘rganish, izlanishga asoslangan ta’lim, tadqiqotga yo‘naltirilgan ta’lim.

Rezyume. Maqolada sinfdan tashqari mashg‘ulotlarning turli shakllari, jumladan kimyo to‘garaklari, loyiha topshiriqlari, ilmiy tanlovlar va virtual laboratoriyalar tahlil qilinib, ularning eksperimental ko‘nikmalar, tanqidiy fikrlash va muammolarni hal qilish ko‘nikmalarini rivojlantirishdagi o‘rni ochib berilgan. Moslashuvchan va shaxsiylashtirilgan ta’lim muhitini yaratishda raqamli texnologiyalar va innovatsion pedagogik usullarning ahamiyati alohida ko‘rib chiqiladi. Olingan natijalar shuni ko‘rsatadiki, mustaqil tadqiqot faoliyatini tizimli tashkil etish o‘quvchilarning o‘quv motivatsiyasini, akademik o‘zlashtirishini va ilmiy tadqiqotlarga tayyorgarligini sezilarli darajada oshiradi.

Ключевые слова: самостоятельная исследовательская деятельность, внеурочное обучение по химии, внеурочная научно-исследовательская деятельность, обучение, ориентированное на учащегося, самообразование, обучение на основе исследования, исследовательски ориентированное образование.

Резюме. В статье анализируются различные формы внеурочной деятельности, включая химические кружки, проектные задания, научные конкурсы и виртуальные лаборатории, а также раскрывается их роль в развитии экспериментальных навыков, критического мышления и умений решения проблем. Отдельно рассматривается значение цифровых технологий и инновационных педагогических методов в создании гибкой и персонализированной образовательной среды. Полученные результаты свидетельствуют о том, что системная организация самостоятельной исследовательской деятельности значительно повышает учебную мотивацию, академическую успеваемость и готовность учащихся к научным исследованиям.

Key words: independent research activity, extracurricular learning in chemistry, out-of-class scientific inquiry, student-centered learning, self-directed learning, inquiry-based learning research-oriented education.

Summary. This article analyzes various forms of extracurricular activities, including chemistry clubs, project assignments, scientific competitions, and virtual laboratories, and reveals their role in developing experimental skills, critical thinking, and problem-solving skills. The importance of digital technologies and innovative pedagogical methods in creating a flexible and personalized educational environment is considered separately. The obtained results indicate that the systematic organization of independent research activities significantly enhances students' learning motivation, academic performance, and readiness for scientific research.

Introdaction. Innovative approaches in education are becoming increasingly relevant due to their effectiveness and teaching effectiveness. One of the innovative forms of teaching modern schoolchildren is the educational and research activities of students, which allow for the resolution of a number of pressing problems, primarily increasing motivation for studying the subject, improving the quality of knowledge in the subject, career guidance, initiative, the ability to cooperate with partners, expanding the scientific worldview, creating opportunities for cooperation between participants in the process, and demonstrating their abilities, identifying interests, and self-expression.

We define the concept of "educational-research activity" as a type of activity aimed at solving the educational tasks set before the student in a creative, non-standard way, as a result of which they acquire new knowledge, skills, and abilities during their activities under the guidance of a teacher-mentor. Educational and research activities that contribute to the development of students' creative abilities should include problem-based and creative tasks, the solution of which often serves to create one's own algorithm based on trial and error.

Thus, the main goals of educational and research activities can be identified: identifying and pedagogical support for gifted children, developing students' interest in science, developing intellectual and creative abilities, increasing motivation for studying subjects, acquiring research skills, developing independent information-search activities, developing research behavior, and acquiring personal values during educational and research activities [3].

The culmination of any educational activity is the result of education – the experience of independent, creative, research work and a series of innovations obtained as a result of such work. We highlight the following learning outcomes of students' educational and research activities:

• subject result – enrichment with general theoretical knowledge;

• familiarization with the subject area of research – acquisition of a certain narrow range of knowledge within the framework of the research problem;

• the result of practical training - the acquisition of certain skills and abilities;

• mastering the methods and techniques of activity used within the framework of the student's research;

• development of the student's personal qualities, formation of personal values, including the development of the individual's research behavior and research position.

The most popular types of organizing students' educational and research activities described in the literature are project, project-research, and research activities. In order to link the types of organization of educational and research activities with the goals and learning outcomes, as well as to determine the important didactic aspects of organizing educational and research activities in chemistry, we organized the "Chemists" scientific circle in secondary schools of the Republic of Karakalpakstan based on a general education institution in 2023-2025. The work of the scientific circle is aimed at the educational and research activities of students in chemistry during extracurricular time.

At the scientific club, students of various ages: from 15 to 17 years old (grades 9-11) had the opportunity to engage in project-research and research activities. Project activity is understood as a type of activity aimed at achieving goals, objectives, and results through reproductive means. Project-research activity is viewed as an activity aimed at designing one's own research, highlighting the goal, task, research hypothesis, and intended product.

In the implementation of project-research activities, the final result can be not only a specific product but also new knowledge acquired by the student during the research process, where the stages of its execution are initially attempted to be predicted. Compiling a research plan is achieved by independently creating an algorithm for solving the problem, often through a series of failures. The result is an understanding of the essence of the phenomenon under study, the discovery of new patterns, and the result is new knowledge. Furthermore, in our view, it is necessary to understand that in some cases, the difference between a project and design and survey activities may be insignificant. Project activity involves not only achieving a specific result formalized in the form of a specific practical product but also organizing the process of achieving this result [1, 2].

During the implementation of the project, it is possible to enrich the student's knowledge with new knowledge. Thus, it can be concluded that the educational results of project and project-research activities can often be partially identical across a range of indicators. We define research activity as a creative process of acquiring unknown knowledge by a student through research aimed at solving educational and research tasks.

When we speak of an educational and research problem, we mean a problem that cannot be solved by the student according to a standard algorithm: solving it requires demonstrating skills in information retrieval, comparison and analysis of facts, and drawing conclusions. The result of solving such a problem is new knowledge. In our view, the main components of research activity: problem-setting, literature analysis, selection of research methods, conducting research, analyzing and summarizing the results obtained, and presenting one's conclusions give the research activity a line of infinity.

If the product obtained during the implementation of project activities is the logical conclusion of the project, then in research activities, new knowledge serves as the basis for a deeper study of the research subject. Based on the results of the club's work, we have reached certain conclusions. From the perspective of choosing the optimal type of educational and research activity, in our opinion, any method of organizing educational and research activity can be considered the most effective, as the application of a particular method depends on the age, psychological, and intellectual abilities of the students and the goals set for them.

In our view, the development of research behavior, research activity, and the formation of an individual's research position through students' educational and research activities can be carried out as effectively as possible within the framework of school project-research and research activities. Approaches to performing such student research should prioritize non-standard, creative, and problem-based situations. This approach is particularly relevant in the study of natural sciences, particularly chemistry. In our view, it is possible to carry out research activities at school, but it is more difficult compared to project and project-research activities. This is due to problems such as the long duration of such research (almost unlimited), insufficient equipment of the school's material base, insufficient qualifications of teachers, and the complexity of the phenomena being studied.

Such research consists of the joint creative activity of the teacher and the student, aimed at studying specific problems outside the curriculum. It is worth noting that postgraduate research can be successfully integrated with interdisciplinary research. As a result of such integration, the teacher's effective work with students is harmonized; the research topic goes beyond the school curriculum and becomes non-standard, problem-oriented, and cognitive.

When a student conducts research in chemistry, this can be work on biochemistry, geochemistry, pharmacy, etc. As an example, work aimed at isolating biologically active substances used in pharmacy from plant raw materials can be considered. In this process, students become acquainted with the most commonly used methods for extracting substances from plants, purifying them, and identifying them using various methods. Such work requires thoroughness and precise analysis from the students.

Methodologic. We consider it necessary to differentiate the organization of students' educational and research activities, taking into account their age characteristics. Analysis of club activities shows that students in grades 9-11 who have just begun studying chemistry are interested in studies that are not time-consuming, but are clear and, of course, yield successful results. At the same time, it is advisable to partially combine the project method with exploration activities. At the initial stage of the student's research, in our opinion, there must be an understanding of the final result, as in this way the student learns to create a theoretical plan for their work and the practical stages of its implementation. It should be noted that at the initial stage of educational and research activities in chemistry, the result of practical training aimed at developing skills in working with chemical reagents, laboratory equipment, containers, etc., is of great importance. In the future, the

acquired skills will contribute to the development of educational outcomes and research behavior.

Here is an example of a project related to partial exploration activities - "metals from mortar." The goal of the project is to obtain metals as a result of a chemical reaction occurring in a solution. This project is carried out for 60-90 minutes, conducting the experiment does not require deep knowledge of chemistry, and minor mistakes made by students will not cause failure, the experiment will be successful. Students must mix certain solutions of substances that form metals as a result of a chemical reaction. The work is performed according to the algorithm. In this process, students develop the skills to work with laboratory utensils and equipment, and to follow the rules for safe handling of chemical reagents. During the experiment, students learn to describe the phenomena associated with the transformation of substances. The project is supplemented by partial search activities in the form of problem situations [4].

For example: how does a change in the conditions of a chemical reaction affect its course? Students should experiment with changed conditions and try to explain the observed differences. The senior school age is considered the most optimal for conducting project-research and research activities. In high school students (9-11 grades, 15-17 years old), a selectively conscious interest in exact sciences, a personal position, and a professional orientation toward the future profession are formed. In our opinion, it is advisable to organize longer research activities at this age, lasting from one week to one month, and sometimes up to several months. Research activities for such an age group should be carried out based on the current problems of modern science. To successfully implement the set goals and objectives, the assistance of researchers from higher educational institutions and research institutes can be used in organizing activities.

For example, when studying organic chemistry in the 10th grade, students can perform research work on the topic "Making glue from milk." The study can be considered in the context of the implementation of "green technologies" – the creation of materials with beneficial properties from raw materials whose processing does not pose a danger to the environment. In this process, students' laboratory skills are developed, a research approach to the problem under study is developed, experimental planning skills are formed, and students acquire additional theoretical knowledge about the properties of substances and phenomena studied within the framework of the project.

The duration of the study can range from a few weeks to several months. The classification of educational and research activities by classroom and extracurricular types is described in detail in the literature. However, lessons may contain only certain elements of educational and research activities, which can be explained by the lesson's time constraints and the dependence of the lesson material content on the curriculum.

We believe that one of the successful methods for conducting research activities in chemistry lessons is solving problem-based situational problems. The main goal of such problems is to teach the student not to reconstruct the obtained information, but to apply it in various situations, to determine the natural-scientific essence, to update the necessary information and to find the correct solution to the problem given in the problem in an implicit form. All of the above helps develop students' critical thinking and logic. In our view, problem-based tasks involving a demonstration experiment can be particularly successful. For this purpose, chemistry possesses rich equipment and a developed methodological framework for conducting demonstration experiments [5].

The preparation of a demonstration experiment in chemistry is often creative in nature and ensures the development of practical skills in working with chemical equipment and reagents. Involving students in conducting this type of experiment can contribute to the formation of both subject-specific and practical learning outcomes of educational and research activities. Attention should be paid to the formation of the student's orderliness. For this purpose, a demonstration experiment is the most successful method, as the staging of many experiments requires meticulous, diligent work. At this point, it is appropriate to speak about the acquisition of personal qualities by students. For example, the demonstration experiment "silver mirror reaction" will be successful if the silver released as a result of the reaction settles evenly on the walls of the vessel in the form of a thin mirror film. If this reaction is carried out without adherence to a precise methodology and the proper balance between the reagents, silver will be released in the form of a black precipitate. At the same time, students can be involved in preparing for the experiment, which contributes to the development of their proficiency.

The experiment can be reinforced with the problem question: "Why is it necessary to strictly adhere to the method of performing a reaction for it to proceed successfully?" Practical work and laboratory experiments in chemistry lessons are usually carried out within the framework of research lessons, which consist of the initial formation of students' research approach. Since most of such work is performed at the reproductive level, it is difficult to speak of the development of research skills. In such cases, it is possible to practice and improve the skills of working with laboratory equipment, laboratory containers, and chemical reagents. In lessons, research skills are developed through practical work of a creative nature. For example, work consisting of identifying encrypted substances or synthesizing a substance according to an independently developed plan under the guidance of a teacher.

Extracurricular work allows the student to conduct educational research more fully and extensively. We see that such activities are carried out within the framework of subject clubs for schoolchildren. It is attributed to the second level of organization of educational and research activities. Extracurricular activities are not regulated by lesson time and do not involve grades for actions performed that are specific to the lesson. The student is given more freedom of movement and has the opportunity to demonstrate their abilities to the maximum extent. Abilities that were previously hidden due to certain circumstances can be identified.

Attention should be paid to the forms of organizing classes in the club. We consider it appropriate to use group forms of instruction for students in grades 9-11. For example, the group project session "Crystals Under the Microscope" for students in grades 9-11 is aimed at

developing students' skills in working with research tools and cooperation skills. The goal of the project is to create photographs of crystals and compare them. To conduct the experiment, it is necessary to: create a micro preparation, calibrate the USB microscope, and photograph the crystals at multiple magnifications. This work requires students to distribute tasks among group members, as the micro preparation prepared according to the written algorithm must be quickly placed on the microscope table due to the high crystal formation rate.

Consequently, the clear and coordinated work of the entire team is essential for the successful execution of the project. Even if students do not achieve good results at first, the teacher can correct their activities in the right direction. After creating the photographs, students can be asked to identify patterns in the structure of the studied crystals. For students in grades 9-11, the individual form of instruction is more effective, as a result of which a teacher-centered approach to the student can be formed. When using such an approach, a unique creative tandem of teacher and student is formed.

As a result of well-planned collaborative work, high educational results can be achieved in achieving the set goals and objectives. In such an approach, the teacher's role should not be dominant. The student should be given a certain amount of freedom in conducting research. However, all occupational safety standards must be strictly observed during the student's chemistry research. Therefore, minimizing the teacher's role in organizing educational and research activities is not always advisable. All research work in laboratory conditions must be conducted under the teacher's supervision.

When working in a chemistry laboratory, one of the most important conditions is for students to know the safety rules and methods of providing first aid in the event of an accident. The selection of a student capable of individual student research should be carried out by the teacher based on their own analytical and diagnostic research based on group sessions in the studio.

It is specifically individual educational and research activities that are characterized as the third level of organizing educational and research activities. At this level, the student is not limited by time; all stages of the student's research are fully carried out at a pace convenient for the student. The student is as independent as possible in their research. Thus, we conclude that in general, educational and research activities should be planned by the teacher, taking into account the diagnostic analysis of various approaches to their organization.

Conclusion. We believe that the most effective way to involve students in educational and research activities and develop their abilities is to involve them in educational and research activities from the age of 13-14 and then gradually develop their skills, abilities and abilities, which is carried out through short-term successful research - projects. At the age of 15-17, students interested in educational and research activities can effectively engage in student research aimed at achieving specific personal results (research competitions, olympiads, admission to higher education institutions in the field of educational and research activities, etc.). At this age, the student is capable of conducting research in a scholastic manner, carrying it out, and analyzing the obtained experimental data. For natural sciences, particularly chemistry, methods of scientific cognition such as experiment, observation, description, and measurement should prevail. In our view, research education in chemistry is less effective without the student's experimental activity. The study concludes that effective implementation of extracurricular research in chemistry requires a well-structured pedagogical framework, integration of interdisciplinary approaches, and continuous assessment of learning outcomes. The results can be applied to improve chemistry teaching practices and to support the development of research-oriented education systems.

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