# ПЕДАГОГІКА І ПСИХОЛОГІЯ РОЗВИТКУ ТВОРЧОЇ ОСОБИСТОСТІ

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## ARGUMENTATION METHOD AS A BASIS IN SOLVING DIDACTIC PROBLEMS IN CHEMISTRY

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The article is devoted to the study of the issue of teaching future chemistry teachers the method of argumentation using chemical experiments and other teaching aids. The examples show the methodology of using a chemical experiment as a didactic task (DT). In this regard, the structural and procedural features of DT and the methodology for solving them are revealed. Moreover, the emphasis is placed on the fact that solving DT in the form of performing a chemical experiment as a specific method of teaching and learning chemistry is possible in the course of all components of the educational program, which are aimed at the formation and development of professional competencies of a future chemistry teacher. The use of innovative technologies in the study of chemistry is due to the fact that it contains inexhaustible opportunities for teaching students at a qualitative level. It provides broad opportunities for the development of students' personalities and the realisation of their abilities. The use of computer technologies affects several channels of perception of the learned (auditory, visual), which allows taking into account the characteristics of each student during training.

**Key words:** argumentation method; didactic task; pedagogical experiment; chemical experiment.

**Максимов Олександр, Кулик Ірина. Метод аргументації як основа вирішення дидактичних задач з хімії.** Статтю присвячено дослідженню проблеми навчання майбутніх учителів хімії методу аргументації з використанням хімічного досліду та інших засобів навчання. На прикладах представлено методику використання хімічного експерименту як дидактичної задачі (ДЗ). У зв'язку з цим розкрито структурно-процесуальні особливості ДЗ та методику їх розв'язування. Причому зроблено акцент на тому, що розв'язування ДЗ у вигляді виконання хімічного досліду як специфічного методу навчання і пізнання хімії можливо в межах усіх компонентів освітньої програми, спрямованих на формування і розвиток фахових компетентностей майбутнього вчителя хімії. Використання інноваційних технологій у вивченні хімії зумовлене тим, що в ній закладені невичерпні можливості для навчання учнів на якісному рівні. Такі технології створюють широкі можливості для розвитку особистості учнів і реалізації їхніх здібностей. Застосування комп'ютерних технологій впливає на різні канали сприйняття інформації (аудіальний, візуальний), що дає змогу під час навчання враховувати індивідуальні особливості кожного учня.

**Ключові слова:** метод аргументації; дидактична задача; педагогічний експеримент; хімічний експеримент.

Introduction. The formation of key competencies declared by the New Ukrainian School in students urgently requires a reboot of the content of higher school didactics and specific methodologies, and in particular, the methodology of teaching chemistry according to the educational and professional programme for training future chemistry teachers. In this regard, the search for an effective method of transformation and assimilation of knowledge and practical skills by students remains relevant. Practice has proven that such a method of teaching chemical disciplines in higher school is research methods (chemical experiment, modeling, measurement, design, construction, solving experimental and calculation problems, etc.), in which the number of student actions is significantly greater than the number of teacher actions. The main method of learning a chemical substance and the processes of its transformation, as well as teaching chemistry, is determined by a chemical experiment and solving experimental problems, the application of which is the prerogative of laboratory and practical classes.

The ascertaining stage of the pedagogical experiment and our observation showed that students traditionally learn the methodology of chemical experiments and practice the technique of chemical experimentation in each laboratory lesson, write reports, and at the beginning of the lesson discuss the theory and rules of work in the laboratory. However, in addition to this, for a future chemistry teacher, an absolutely necessary ability is to argue one's own point of view based on the results of the experiment, to convince with the help of scientific facts, demonstrated principles, laws, etc. The teacher must be a leader of dialogical interaction with students, possessing mechanisms of speech influence on them during the demonstration of chemical substances and processes, as well as when they perform laboratory experiments. Mastering such skills is possible only through the process of learning the method of pedagogical argumentation, using the means of chemical disciplines and innovations in the methodology of teaching chemistry. Innovative technologies significantly enhance the motivation to study chemistry, increase the level of individualisation of learning, and intensify the learning process.

Today, computers are becoming an indispensable attribute of our lives, and the latest information technologies create new opportunities for a person to obtain knowledge.

Analysis of scientific research on the problem of teaching students the method of argumentation indicates an intensive search for methods of using means and methods of teaching chemical science. Thus, the founder of this direction should be considered (Erduran, 2019, 300 p.), who, together with like-minded people, made the argumentation model (Toulmin, 2015, pp. 64-68) a methodology for discursive teaching of natural sciences and chemistry in particular (Yilmaz, 2017, pp. 1443-1461). Chemical disciplines have such a means of learning as an experiment with substances, which allows establishing educational (and they are also scientific) facts, principles, theories, laws. This forms a theoretical basis for a reasoned belief in the truth of the essence of a chemical or physical phenomenon. However, research in this area is lacking, and the lack of methods for teaching students the method of argumentation in chemistry and developing their readiness to teach students to convince opponents in dialogue, relying on the obtained scientific chemical facts, impoverishes the teacher's didactic arsenal (Aydeniz, 2012, pp. 1303-1324).

The goal of this study is to show examples of the methodology of using a chemical experiment as a method of pedagogical argumentation in proving the truth of the observed phenomenon, in explaining the laws of production processes and nature; draw attention to the need to form in students – future chemistry teachers the ability to teach students to defend a scientific point of view with arguments. the use of innovative technologies is to form the development of the student's personality, the disclosure of his abilities and talents. in the context of today's educational realities. This goal can be specified as the preparation of a competitive specialist in the field of chemistry, who can flexibly respond to changes in life.

For modern education in Ukraine, it is important to introduce systemic changes, updates the content, forms, methods of education, in particular in general secondary education. Innovative activity is gaining significant strength and importance, as stated in the relevant regulatory documents, in particular in the Laws of Ukraine «On Education», «On General Education Institution», «On Innovative Activity», in the Regulation of the Ministry of Education and Science of Ukraine «On the Procedure for Implementing Innovative Activity in the Education System of Ukraine».

The task of the study: in the new education system, students master the skills and abilities of self-development of the personality, which is largely achieved through the implementation of innovative technologies for organising the learning process.

At the same time, personality-oriented innovative pedagogical technologies can and should be used. The effectiveness of their use largely depends on how the creative potential of the student’s personality is realised. Therefore, the priorities in the teacher’s activities must change. From the explanatory-illustrative method, from the transmission of ready-made educational content, from the enlightenment of students, the teacher must move on to new personally-oriented methods, in which the creative-activity component is strengthened, which determines the emergence of education innovations designed to significantly change the educational process (Erduran, 2004, pp. 915-933).

Materials and methods. One of the main ideas of the pedagogical experiment we organised with students – future chemistry teachers – was to convey to them that argumentation is a form of scientific discourse, which is absolutely necessary in the logical construction of the explanation of principles, models or theories. The formation of argumentation, as a scientific habit of mind, can be better carried out through appropriate training (Pometun, 2004, 192 p.), which is what we actually do in laboratory classes in organic chemistry and chemistry teaching methods. We relied on the thesis that a chemical experiment is an effective argument in proving the truth when solving didactic tasks, which are structural elements of the content of a laboratory class (or a chemistry lesson at school). A laboratory class has a topic, a didactic goal and a content, which consists of several didactic tasks, i.e. experiments. In turn, didactic tasks have

their own goal and prescribed conditions (methodology) for their achievement. The solution of the didactic task can be carried out theoretically or empirically (Voronenko, 2010, pp. 4-6).

In the first laboratory lesson, students explained the meaning of the argumentation method as a way of substituting the basic concepts (generalised types of knowledge and forms of thinking) learned in the process of studying chemistry (oxides, acids, signs of chemical reactions, etc.) for an expressed opinion, hypothesis or any action from the technique of chemical experimentation with the aim of their public defense, explanation or recognition. Argumentation is a judgment based on the formed concepts about chemical matter and processes with it in order to convince the opponent (interlocutor) in a dialogue. We showed that argumentation consists of logically constructed sentences that materialise the thought, and the art of persuasion, subjugation of the feelings, thoughts of the interlocutor. We considered the main aspect of argumentation to be factual, which informed about the obtained facts, phenomena, which became arguments to substantiate the hypothesis put forward or confirm regularities, etc. (Dyakova, 2007, pp. 12-14).

Facts and phenomena are the obtained results of chemical or physical experiments, the accumulation of which is the basis for analysis, interpretation, judgments that lead to certain conclusions. Obtaining facts is the process of solving didactic tasks, which in our case were chemical or physical experiments. To do this, students were taught to ask the question «For what purpose are we conducting an experiment?», formulate a hypothesis (the expected result of the experiment), build a sequence of subject-manipulative actions, record the results according to certain signs (precipitation, release of a carbonated substance, change in the color of the solution, etc.), interpret what was seen, draw a conclusion using arguments.

In addition, students were required to understand the structure of the didactic task, the ability to distinguish the goal from the conditions for its achievement. For this, an example was given of determining the acidity of the soil using various methods and means. Thus, the soil environment can be determined with indicator paper, using baking soda or acetic acid etc. The students themselves were convinced that the goal of this didactic task is the same, but the methodology, that is, the conditions for its achievement, are different, which also determines the result obtained (qualitative or quantitative indicator). The students were also explained that all participants in the experiment would be divided into a group of adents who prove the truth using theoretical knowledge and a group of empiricists. During the experiment, the teachers consciously redistributed the roles of theorists and empiricists between groups of students. This was done so that the students:

1) could master the algorithm for combining the technique of thinking with the technique of persuasion, alternately applying either arguments from the theory or facts from chemical (physical) experiments;

2) felt the advantage of the argumentation process based on the use of the results of a chemical experiment over the process of persuasion using theory (Zadorozhny, 2009, pp. 140-142).

Thus, two groups of students with a total of 27 people were divided into group A (12 students) and group B (15 students). When studying the topic «Amino acids» to clarify the physical and chemical properties of amino acids, students in group B were asked to prove theoretically that amino acids consist of bipolar ions and add a neutral medium to the solution, and students in group A were asked to prove this experimentally. Students in group A proved with arguments that the melting point of aminoacetic acid is 232°C and explained this by the formation of a bipolar ionic compound – an inner salt. As is known, substances with a crystalline ionic lattice are well dissolved in water, but are refractory. The experiment also became a convincing argument in the case of clarifying the medium of a glycine solution, in which there is one carboxyl and one amino group. This was confirmed by indicator paper. In the presence of these functional groups, amino acids exhibit amphoteric properties, which was proven by the reaction of glycine with hydrochloric acid and sodium hydroxide. At the end of the lesson, students from both groups answered the questions: «Why is aminoacetic acid refractory?», «What environment do amino acid solutions have?», «Does glycine interact with acids?», «Does glycine interact with alkalis?», «Is glycine soluble in water or not?», «Can amino acids interact with each other?». For correct answers to the first question, a maximum of 5 points could be received, and for the others – 1 point each. In another case, students were asked to express their opinion on the chemical properties of glucose, based on its molecular formula $C_6H_{12}O_6$. Students in group A (12 people) had ball-and-stick models, computer virtual images of a glucose molecule in space, and, of course, the knowledge they had learned since high school to prove that glucose exhibits the properties of polyhydric alcohols and aldehydes. Another group B of 15 students experimentally proved that glucose exhibits the properties of an aldehyde alcohol. That is, this time the groups swapped roles of «theorists» and «experimenters». The experimenters carried out the reactions of glucose oxidation with an ammonia solution of argentum (I) oxide to form gluconic acid (the «silver mirror» reaction) and oxidation with copper (II) hydroxide in an alkaline medium to form a dark blue

solution of copper (II) gluconate. Both reactions are characteristic qualitative reactions to the functional aldehyde and hydroxyl groups.

Creating an atmosphere of interest for each student in the work of the whole class:

1. Encouraging students to make statements;
2. Using different methods of completing tasks;
3. Modeling life situations;
4. Creating pedagogical situations of communication, exchange of ideas, which allow each student to show initiative, independence, and ingenuity in the methods of work.

The transition of modern society to the information age of its development puts forward one of the main tasks for school education – the formation of the foundations of the information culture of the future specialist. The implementation of this task is impossible without including the information component in the system of chemical education.

In modern conditions, it is necessary to prepare the student to quickly perceive and process the incoming information, to successfully display and use it. The final result of the introduction of information technologies in the process of teaching chemistry is the mastery of the computer by students as a means of knowing the processes and phenomena that occur in nature and are used in practical activities (Manoilova, 2001, pp. 24-26).

***The method of argumentation in chemistry lessons as an innovation.***

It is necessary to start work on teaching schoolchildren to debate with the argumentation method, the argumentation method is used in the process of discussing questions and in the process of performing exercises in which it is necessary to take and clearly argue a certain position on the discussed problem.

The argumentation method teaches schoolchildren in chemistry lessons to create and formulate arguments, express opinions on a discussion question in a clear and concise form, and convince others. The organisation of teaching in chemistry lessons using the argumentation method is as follows:

1. Providing materials that define 4 stages of the method:

1.1. Express your own opinion, explain what your position is.

1.2. Explain the reason for the emergence of this opinion, that is, what the evidence is based on.

1.3. Give examples and additional arguments in support of your own position, give facts that demonstrate your evidence.

1.4. Summarise your own statement.

2. Explain the mechanism of the stages of the argumentative method and answer possible questions from students. Give an example of each stage.

3. Invite those who wish to try using this method to any problem of their choice.

4. Check how well the students understand the mechanism of using the method. The stages can be adapted by inviting students to give several options for their own thoughts or examples.

5. When the formula is clear to all children in the lesson, it is worth offering them to try it themselves. It is worth using the argumentative method in chemistry lessons in all lessons where children are required to argue their own thoughts.

The method of argumentation consists in the special selection and application of logical evidence to convincingly prove the truth of a certain position. For this purpose, various means of psychological influence on the student are used, depending on their purpose, direction, and force of action, or a special sequence of arguments, which should not only demonstrate the validity and usefulness of the argued position, but also gradually increase the persuasiveness of the proof.

Perfect mastery of this technique provides an opportunity to form preliminary considerations and ideas quite effectively, to develop a certain position regarding the problem under discussion. At the same time, mastery of the argumentation technique can provide a significant change in the opinion or position of the interlocutor that has begun to form unfavorable for you, or an unfavorable situation that develops during the conversation, as well as ensure effective neutralisation of his negative reaction to your proposals, which will be discussed below (Melnychenko, 2010, pp. 12-16).

Additional argumentation of your position is necessary in order to convince the interlocutor of its fairness, expediency and rationality as an effective means of solving the problem under discussion. Persuasion is an influence on the consciousness, feelings and will of a person by communicating, explaining and proving the importance of a particular position, view, thought, statement or action or proving their inadmissibility in order to force the interlocutor to change his own views, attitudes, positions, attitudes and assessments or to share thoughts or ideas.

Argumentation has a rather complex structure, which has knowledge, emotions and volitional components. It is sometimes very difficult to convince another person with categorical judgments, even if they are correct, because defense mechanisms are triggered in him. The scheme of consistent psychological influence on the interlocutor's consciousness with the aim of convincing him looks like this: attract attention, arouse interest, and subsequently a desire to act.

***Using the argumentation method together with other methods***

Argumentation is a dialogical activity that is based on two key principles, namely: commonly held beliefs and practicability. Arguments are based on premises that are not necessary but only commonly accepted, such as values, assumed causal relationships, and commonly accepted definitions. Given the endoxic nature of the claim, arguments are inherently refutable, namely they can be rejected if one of the references is challenged or refuted.

For this reason, argumentation is mainly associated with the dialogical and dialectical practice of considering a problematic issue, giving reasons for supporting and criticising a particular claim.

Argumentation can be considered one of the fundamental tools for the «social constitution of knowledge». The crucial role of argumentation in teaching and learning, especially in the field of science education, is emphasized in many studies. Teaching can be seen as an argumentative dialogue, as it aims to modify and develop students' «private understanding», showing its limits and drawing on it to explain new phenomena.

One important tool to achieve this goal is the use of arguments. Students' arguments can be encouraged to illuminate the assumptions on which they are based. Such prior beliefs and background knowledge can become the subject of further argumentative exchanges in chemistry lessons, aimed at providing arguments that demonstrate their incompleteness and support the scientific point of view. For this reason, argumentation tools are fundamental both for improving children's critical thinking skills and for improving classroom interactions so that students' prior knowledge can be better expressed, examined and developed into more detailed theories.

Advances in argumentation theory can provide useful resources for improving argumentation in classroom communication, both in the form of dialogical argumentation models and logical argumentation structures. In recent years, several studies have addressed the critical issue of implementing argumentation theory in the educational process. In particular, argumentation practices have been examined from two different but related perspectives:

1. Dialogic, focusing on supporting claims with arguments.

2. Structural, focusing on constructing arguments.

On the one hand, the nature of classroom conversations has been investigated in terms of argumentation practices, such as providing evidence to support a point of view or refuting and questioning other positions. According to this perspective, dialogical argumentative activities can be seen as tools to promote students' critical thinking in chemistry classes. On the other hand, other studies have taken into account a more specific dimension of argumentation, namely argument construction.

Theories of argument structure have been applied to the educational process to help students better process their written arguments. Analytical models have been developed that have attempted to improve the articulation of field-independent relationships, such as between premises and conclusion, or field-dependent relationships, such as between specific evidence, guarantees, and claims. In this context, the argumentation method has been used mostly as an educational tool to improve students' understanding of scientific problems and to assess the quality of argumentation in the classroom, including support for claims and refutations.

Educational practice is complex, and the decision to choose the most appropriate method to support it is difficult, mainly because of the multitude of variables and objectives that coexist and enrich learning in a specific context. The same complexity applies to the analysis and evaluation of students' oral and written argumentation.

Argumentation in an educational context raises a number of issues, including philosophical, psychological, cognitive and logical aspects, which make it virtually impossible to explore or even consider within the limited framework of a special issue. Nevertheless, if one of the main goals of educational research is to inform educational practice, and educational practice should be reflexive and at the same time based on reliable and tested theories, then researchers in this field should be constantly informed about developments in the theoretical methods they use.

To this end, by focusing on pragmatic approaches to argumentation that combine the dialogic dimension with the logical (argumentative-evaluative) one can identify specific research directions and, more importantly, specific methods to which this special problem can contribute. The most important methods regarding the phenomenon of argumentation as an educational practice that can be considered are the following:

1. Applying and developing dialogic models to analyse and evaluate student-teacher interactions.

2. Developing and applying coding schemes to analyse peer dialogues in a face-to-face or computer-supported context.

3. Codifying and evaluating argument structures in written communication tasks.

4. Developing structured or semi-structured interventions to support students who argue with the help of external representations (i.e. audiovisual materials, maps, diagrams, etc.).

In all these cases, scholars and researchers tend to apply methods that are already established in the field of education, such as the model of argument structure analysis of the scholar Diane Kuhn, the model of

argumentative dialogue analysis of the scholar Mark Felton, or the popular Toulmin argumentation template.

From a theoretical perspective, such models have been refined in argumentation theory by several scholars who have developed more thorough analytical tools, such as the theory of argumentation schemes, dialogue types, or the model of critical discussion within the framework of the theory of pragma-dialectic. Although the influence of these and other argumentation theorists such as Perelman, Albrechts Titheka, and Plantin has been crucial in shaping educational research on argumentation, the connection between theory and practice is rarely made explicit as a background justification for argumentation methods used. The specific aim of this special issue is to bring together approaches in education that use tools developed in argumentation theory and models proposed in argumentation that are applied or can be applied in the field of education.

The purpose of using argumentation teaching is, on the one hand, to provide educational scholars with the latest theoretical developments in argumentation and to suggest ways to use them for teaching and assessment purposes. Advances in argumentation theory and research in education are increasingly intertwined. On the one hand, education is a natural and traditional application of argumentation research. Since the time of Plato, dialogue and dialectical reasoning have been considered a key component of education. On the other hand, there is a growing interest in argumentation in education. Argumentative, collaborative dialogues and argumentative discourse structures have been shown to be highly effective teaching strategies for improving students' critical skills and addressing prior knowledge issues, including misconceptions and the basis of disagreement.

This principle underlies the idea of learning as argument, that is, the view that education should help students construct their knowledge through reasoned interaction. Through the use of arguments, it has been shown that students acquire not only knowledge of concepts, but also the foundations on which such concepts are based, revising their prior knowledge and improving their epistemological understanding.

Thus, we can list some of the most important areas in which argumentation theory meets educational practice:

1. Detecting errors in the learning process. The term «error» is an ill-defined term, since there is no generally accepted theory of errors. Until now, the most prevalent theories of errors have been pragma-dialectical theory and pragmatic theory. More precisely, for pragma-dialectical theory, an error is a departure from the rules of critical discussion, a speech act that somehow prevents the resolution of a dispute within the framework of an ideal model. In the pragmatic theory of error proposed by Walton, an error is rather an argument or a scheme of argumentation that may be acceptable and reasonable in some contexts, but may be misleading in others. More recently, the pragmatic theory of error has been combined with the already expanded idea of argumentation schemes to give rise to what is called the «paraschematic» theory of error.

The persuasive effect of errors is explained by the combination of the «logic» of errors with their psychological, heuristic dimension. From this perspective, the mechanism of heuristics is presented as a decision-making process that mediates between the two concepts of error and the correct scheme of argumentation. In other words, someone may choose to jump to a quick conclusion that leads to a preliminary conclusion (by providing arguments that only appear better than they really are), rather than to advance a carefully evaluated opinion based on properly collected and weighed evidence, which is one of the basic requirements in any educational system.

In the educational field, researchers have mostly considered fallacies through the identification and evaluation of poor arguments. Researchers have mainly focused on:

1. Identifying fallacies in written texts produced by students.

2. Encouraging students to identify them in order to assess their understanding of arguments and evaluation skills.

Fallacies are very important in chemistry teaching because they represent faulty reasoning structures or biases that can usually be found in students' oral and written justifications of their points of view. However, the concept of fallacies is controversial in argumentation theory and can be approached from different perspectives.

For example, from a pragmatic perspective, they are usually viewed as strategic arguments under certain conditions, while from a cognitive perspective, they can be viewed as based on heuristics that underlie all human reasoning. Understanding these different approaches and dimensions, and adopting an adequate theory for analysing and evaluating students' errors in the classroom, are fundamental to developing accurate research and teaching practices.

2. Dialectical toolkit. Dialogue theory is one of the most important approaches and strands in argumentation theory. From this perspective, arguments unfold dialectically as an exchange of argumentative speech acts between two or more students. Such speech acts are also described as dialogic moves, following the metaphor of a language game in which each player contributes to the common goal of the interaction.

In this approach, two elements are crucial for understanding and appreciating the nature of the argumentation process. The first is the refutable nature of arguments, which means that each proposition can be refuted by the proponent or by other students.

The second refers to the typology of dialogic macrostructure, which is determined by the type of communicative goal to be achieved. The scholar Walton identifies 7 types of dialogue that can be considered argumentative depending on the quantity and quality of argumentative structures. Recently, the dialectical principle of critical questions has been added to the schemas of argumentation so that each argumentative conclusion can be evaluated dialogically. To this end, several argument diagram or mapping tools have been developed that highlight the internal structure of an argument and support its dialogical evaluation. From an educational research perspective, several methods have been proposed that analyse argumentation either as a dialogue between peers or as a classroom interaction.

***Application of the argumentation method together with interactive technologies in the study of chemistry in grades 7-9***

The «method of argumentation» should be used at the stage of studying new material, when controversial questions arise and it is necessary to clearly argue the position on the problem, to convince others of the correctness. Children provide answers to the questions posed, arguing the position on the problem according to this algorithm:

The speech when studying chemistry in grades 7-9 should be clear and include the following points:

1. Position – «I believe that…» (expression of opinion and explanation of point of view).

2. Justification: «…because…» (the reasons for the emergence of this opinion, evidence in support of the opinion and position are given). Examples and facts that confirm the opinion, position.

3. Conclusions: «Thus, I believe…»

Stage of generalisation and systematisation of knowledge:

Eighth grade. Topic «Dependence of physical properties of substances on types of crystal lattices».

Question: «What types of chemical bonds exist in substances with crystal lattices?»

a) atomic;

b) ionic;

c) molecular?

Give specific examples.

Question: «What chemical bonds hold together:

a) atoms in a molecule;

b) molecules in a molecular crystal;

c) ions in an ionic crystal;

d) atoms in an atomic crystal?».

Ninth grade. Topic «Electrolytes and nonelectrolytes» – demonstrate experiments on the electrical conductivity of solutions:

a) distilled water;

b) tap water;

c) solid table salt and its solution;

d) hydrochloric acid solution.

Question: «Why do some of these solutions conduct electric current, while others do not?». Justify your answer.

The group research method can be used together with the argumentation method, these methods should be replaced at the stage of studying new material. As an example:

Eighth grade. Topic «Construction of matter».

The class is divided into two groups. A senior is selected in each group. The groups are given texts with educational information, which is a special characteristic of a certain type of crystal lattice and tasks. The group of experts works with a textbook and additional literature and receives general information. Ten minutes are allotted for work.

Tasks for both groups:

1. What parts are located in the nodes of the crystal lattice that you are studying?

2. Name the type of chemical bond and the type of chemical elements that create this type of crystal lattice.

3. Indicate the characteristic physical properties of a substance with a given type of crystal lattice.

4. Enter examples of a substance.

After completing the work, each group reports and writes the information received on the board in the table:

*Table 1*

**Results from determining crystal lattice types**

| Comparative characteristics | | Types of particles in lattice sites | Type of chemical bond | Nature of chemical elements | Examples of substances | Physical properties |
|---|---|---|---|---|---|---|
| Types of crystal lattices | 1. atomic | - | - | - | - | - |
| | 2. molecular | - | - | - | - | - |
| | 3. ionic | - | - | - | - | - |
| | 4. metallic | - | - | - | - | - |

Schoolchildren fill in the table in notebooks. A group of experts analyses the completed table, comparing it with their own information and draws conclusions regarding the dependence of the characteristics of substances on the type of crystal lattice.

Seventh grade. Topic «Corrosion of metals». 5 experiments are prepared in advance, demonstrating the corrosion of an iron nail in the presence of various reagents. Groups, moving around the class, analyse the results obtained, then discuss them.

At the stage of the lesson of generalisation and systematisation of knowledge, it is worth using the interactive technology «Unfinished sentence» with the argumentation method. As an example: «Water as a solvent. The physicochemical essence of the dissolution process».

1. Today in the lesson we got acquainted with ... (the structure of the water molecule, the concepts of «dipole» «hydrogen bond»).

2. A water molecule is created using…(two unpaired p-electrons of an Oxygen atom and s-electrons of two Hydrogen atoms).

3. Water is a polar solvent because…(created by polar covalent bonds).

4. This information allows us to draw a conclusion about…(solubility of substances of different structures).

5. Substances…(with polar covalent bonds) dissolve well in water.

6. Insoluble or sparingly soluble in water are those substances that are created by…(non-polar and slightly polar covalent bonds).

7. A dipole is…(a system that has two oppositely charged poles).

8. A hydrogen bond is…(electrostatic interaction between molecules involving Hydrogen atoms).

Interactive exercises «Incomplete Sentence» in combination with the argumentation method encourage children to be important in the lessons in order to give the correct answers.

That is, argumentation of learning is a form of cognitive activity that creates comfortable conditions for the student's learning, in which the student feels his own need, develops his own abilities and inclinations, gains success, develops skills for working together in a group, collective, and forms communicative competences.

Results and discussion. In the pedagogical experiment, the «cross» method of forming students' ability to apply arguments from theoretical knowledge or obtained during chemical and physical experiments was purposefully used. This allowed students to see for themselves the effectiveness of using a chemical experiment as a materialised argument, which obviously proved the correctness of the hypothesis. Thus, when studying the properties of amino acids, out of a maximum of 10 points for answers to control questions, students of group A, who experimentally proved the structure of glycine, had a weighted average value of 8 points, and students of group B (theorists) had 5 points. In a lesson on the study of glucose, analysis of the structure of its formula and proving the existence of aldehyde and carboxyl functional groups in it, students of group A were «theorists», and students of group B were experimenters. Current control of the acquired knowledge with the argumentation of their answer was carried out at the end of the lesson, where students of both groups were asked to prove the formula for the existence of a glucose molecule (cyclic or chain). In the dialogue, students from group A, who defended the existence of a cyclic form, could not explain why glucose reacts with an ammonia solution of argentum oxide. Among students from group B, there were more «supporters» of the chain form of glucose, but they agreed with the possibility of a rearrangement of atoms at the moment of rapprochement of the ends of the carbon chain, which led to the formation of a cyclic form. They also explained that the cyclic form can be transformed into a chain form under the influence of reagents, for example, during the «silver mirror» reaction or during the oxidation of cuprum (II) by hydrocyanic acid in an alkaline medium. They were convinced of this by a chemical experiment.

The topic for discussion remains the issue of experimental verification of the levels of achievement of students' ability to apply the argumentation method during practical work at school.

Conclusions. During the formative stage of the pedagogical experiment, the effectiveness of using chemical experiments as an argument in explaining the theoretical provisions of the structure of organic compounds was confirmed. The results of a small sample of students (27 people) give us the right to state the following:

a) the identification of the methodology for performing a chemical experiment with the structural and procedural side of the didactic task increases students' motivation to solve them and to understand the productivity of the habit of proving the truth by the method of argumentation, having mastered which it will be easier to teach schoolchildren;

b) knowledge of the methodology for solving didactic tasks gradually produces an algorithm of actions that leads to conviction in achieving the goal, which is defined as the method of argumentation.

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