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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

ORGANIZATION OF INDEPENDENT WORK OF STUDENTS IN CHEMISTRY IN SECONDARY SCHOOLS

Specialty**:** 5801.01 – "Theory and methodology of teaching and upbringing (methods of teaching chemistry)"

Field of science: Pedagogy

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GENERAL CHARACTERISTICS OF THE STUDY

Relevance and degree of elaboration of the topic.

After the independence of the Republic of Azerbaijan, fundamental reforms were initiated in one of the most important and relevant areas of education, curricula were approved that meet the educational standards of the most developed countries of the world, and it was entrusted to build a new education system that will serve the national goals facing the education system.

One of the important issues facing the Azerbaijani system of science and education (according to the decree of the President of the Republic approved in 2013) is the formation of an established personality.

At present, the formation of students as individuals in general education schools and the improvement of the quality of their knowledge is served by a new educational reform.

Today we live in an environment where science, technology and technology are developing rapidly.

The rapid changes taking place in today's environment require new methods of forming the student's personality.

One of the main tasks facing the new education reform is the formation of physically healthy students who have acquired vital knowledge and skills. In order to adapt to the rapidly changing developing environment, students must have the necessary knowledge and skills, strive for self-education, to realize their knowledge and skills.

With the active activity of the teacher, it is difficult to form students' life knowledge and skills in the process of educational training. In education based on illustrative and explanatory memory, the assimilation of the theoretical foundations of the subject prevails, the content of the taught subject is not adapted to the needs of modern life. During the training period, some teachers do not take into account individual abilities, personal characteristics, and qualities of students. In modern times, when science and technology are rapidly developing, the main content of education should be

formulated in such a way that this content develops students' logical thinking, helps to understand the causes of phenomena, and form the ability to make the right decisions at the right time and in the right place. Therefore, the learning process of students should be built in accordance with their interests, abilities, level of knowledge, modern teaching methods should be used in chemistry lessons. Only with the help of this method it is possible to form students' life-important knowledge and skills in chemistry. The construction of the educational process according to modern methods and principles of teaching will help students to assimilate the most important theoretical information related to the subject, interact with other subjects, perform individual work, acquire independent knowledge, implement the acquired knowledge and skills, apply them in the process of life.

The main problem of modern education is to update its structure by modernizing the forms and methods of teaching. Currently, new learning technologies and interactive teaching methods are being introduced in our schools. It should be noted with regret that based on the observational and questionnaire surveys conducted by us, it was found that in most general education schools, the vast majority of teachers do not yet have time to apply active teaching methods. The main reason why this problem has not been solved is the insufficient conduct of modern research works teaching methods of active learning, insufficient publication of new scientific and methodological literature.

The importance of independent work of students in the assimilation, as well as the comprehension of theoretical knowledge in chemistry, its patterns and patterns is much greater.

To date, neither several books, textbooks, scientific papers on obtaining theoretical knowledge in chemistry have been published, nor serious research work on organizing and conducting independent work of students in chemistry, if it is published.

Currently, due to the volume of chemistry textbooks used in secondary schools, the lack of study hours allocated for teaching chemistry, the incorrect organization of practical classes in chemistry, it becomes impossible to determine daily with the help of

practical classes how students acquire knowledge in chemistry. For this reason, we have begun to study the role of independent work of students in the development of chemistry to solve this problem.

Serious research work concerning the role of independent work of students in mastering the theoretical foundations of chemistry has not been conducted, the practical experience of teachers on this topic has not been analyzed and generalized. Considering all of the above, we consider it necessary to conduct research on the topic "Organization of independent work of students in chemistry in secondary schools".

The main issue confirming the relevance of research work for the modern era is the implementation of standards 3.1; 3.2 and substandards 3.1.1; 3.2.1 in chemistry (see the documents of the Curriculum in Chemistry).

The object and subject of the study.

The object of the study is the process of teaching chemistry carried out in secondary schools of our republic.

The subject of the research is the methods of using modern teaching methods for organizing and implementing independent work of students in chemistry in understanding the theoretical foundations of chemistry in grades VII-XI of secondary schools.

Goals and objectives of the study.

The aim of the study is to improve the quality of teaching chemistry with the formation of knowledge and skills that can be obtained by students as a result of organizing and conducting independent work of students in chemistry in general education schools, identifying the merits and significance of independent work of students in in-depth mastery of chemistry, developing recommendations for chemistry teachers with a generalization of the results obtained.

Research objectives-to study the experience of chemistry teachers in solving the problem;

-analyze methodological and scientific-pedagogical literature on the topic;

- to determine the ways of organizing and conducting independent work of students on the in-depth development of

chemistry, ways of their application;

- organization and implementation of independent work of students in chemistry using active teaching methods and interactive teaching methods;

- to prove the reliability and effectiveness of modern teaching methods, which we will apply, through the independent work of students.

The main provisions submitted for protection:

- formation of the educational environment and effective functioning educational process with the application of methods of organization and implementation of independent work of students from chemistry;

- increasing interest in chemistry in students who study poorly through the organization and application of independent work of students from chemistry in the educational process, its influence on the qualitative assimilation of topics in chemistry;

- the influence of chemistry on the effective use of resources necessary for deepening student knowledge through the organization and implementation of independent work of students, increasing cognitive activity of students, the development of the speed of perception of theoretical knowledge.

The scientific novelty of the study is that for the first time in general education schools, methods of active training methods and application and use of modern training technologies have been determined for the organization and implementation of independent work of students in the process of teaching chemistry and extracurricular activities for the assimilation of theoretical knowledge from chemistry and the formation of skills.

Theoretical and practical significance of the study.

The theoretical significance of the study lies in the fact that identifying ways to use modern methods of teaching the organization and implementation of independent work of students in teaching chemistry in grades VII-XI of secondary schools, determining their application, as a result of which giving the necessary recommendations to chemistry teachers can enrich the methodology of teaching chemistry with new scientific - pedagogical provisions.

The practical significance of the study is based on the results of the conducted scientific and pedagogical research, which can be applied at lectures and seminars on chemistry courses at faculties that train chemistry teachers in currently operating universities, in the development of teaching aids on interactive teaching methods, active learning methods, teaching chemistry in accordance with the requirements of modern teaching methods in grades VII-XI of secondary schools.

When applying the results of the study, students of general education schools or university students will clearly understand the relationship between independent work in chemistry and the theoretical foundations of chemistry, take them into account in their life, determining the role of chemistry in their daily lives. Pupils of secondary schools and university students, carrying out independent work in chemistry in extracurricular activities, form their creative abilities and better master the subject of chemistry.

Approbation and application. Implemented methodological recommendations and guidelines for organizing and conducting independent work in chemistry using the results obtained at the end of the study, teaching aids, pedagogical recommendations and proposals for improving the teaching of chemistry in secondary schools. The results obtained in connection with the study were consistently reported and presented at international scientific-methodical and scientific-practical conferences, pedagogical lectures, before teachers of the city and district schools.

The results of the research were reflected in 15 scientific and methodological articles and 4 dissertations.

The results of the dissertation work were discussed at the following scientific conferences and published in the conference proceedings:

Academician Yu.N. International Scientific Conference "Actual Problems of Modern Chemistry", dedicated to the 90th anniversary of the Institute of Petrochemical Processes named after Mammadaliyev (Baku, 2019), III All-Russian Scientific and Practical Conference. "Education, upbringing and pedagogy: traditions, experience, innovations", Russian Federation, (Penza, 2020),

materials of the II Republican scientific conference on the topic "Fundamentals of the Humanities and Social Sciences" (Baku, 2020), scientific and practical materials II International Scientific and Practical Conference, (Belarus, Baranovichi, 2021).

The name of the organization in which the dissertation work is being carried out. The dissertation work was done at the Ganja State University.

Author's personal contribution. The main ideas embodied in the dissertation, the formulation of the problem, the directions of research and their implementation, the analysis and generalization of the results obtained, the conduct of experimental studies were carried out personally by the author.

Scope and structure of work. The dissertation work consists of an introduction, 3 chapters, conclusions, 97 lists of references. The dissertation is covered with 5 tables and a total of 134 printed sheets. The dissertation work of the table contains 180760 characters, excluding the list of references.

THE MAIN CONTENT OF THE STUDY

In the **introductory** part of the dissertation, the relevance of the presentation is substantiated, the goal and objectives are defined, the main provisions submitted for defense, the scientific novelty of the work, its theoretical and practical significance, and the results obtained are commented and indicated. **Chapter I** of the dissertation "The essence, content of the organization and methods for the implementation of independent work of students in chemistry in secondary schools" considers, analyzes the scientific results of research work on the methodology of teaching chemistry over the past 30 years, and summarizes the practical results of research.

The second paragraph of Chapter I explains the significance of experiments as independent work of students in chemistry in secondary schools.

Further, the analysis of the pedagogical activity of teachers in the dissertation shows that if experiments (practical and laboratory work) are used when teaching chemistry in extracurricular activities

in grades VII-XI of secondary schools, then the quality of teaching chemistry and educational activity increase.

In the Law of the Republic of Azerbaijan On Education (2009) and other state documents on education, the most important tasks set for the organization and management of education in general education schools are as follows:

- The acquisition by students of theoretical and practical significant knowledge and skills in chemistry;
- Formation of practically significant habits and skills among students;
- Formation and development of logical thinking, cognitive abilities of students.

The subject of chemistry plays a very important role in the implementation of these tasks. Chemistry teachers of general education schools can use the lesson, chemistry evenings with auxiliary forms of the lesson, circle classes, practical and laboratory classes, question-answer quizzes as a very powerful means of influence to implement these tasks. The organization of independent work of students in chemistry differs sharply from chemistry lessons both in content, focus, nature, and in the ways of its implementation. Experiments in chemistry are organized and conducted in various forms, based on the interests of students in the subject of chemistry, the forms and desires of independent work.

Evenings of chemistry, organized and held in grades VII-XI of general education schools, among independent studies of students, are remembered for the longest time in the school life of students and are of great importance.

Chemistry evenings are very helpful as independent work of students in fulfilling the educational tasks assigned to the school, and create conditions for obtaining the following results:

- Enriches the theoretical knowledge of students in chemistry with significant evidence (facts), increases students' interest in chemistry;
- Revealing the creative abilities of students, deepens the content of their knowledge, and also forms their skills that will be applied in everyday life;

- Allows students to a certain extent become familiar with new scientific discoveries discovered in chemistry.

Chemistry evenings, aimed at generalizing and expanding students' knowledge of chemistry, create the best conditions and prepare them for practical life.

Chemistry evenings, related to independent work of students in chemistry, can be held on a school-wide scale and with students of a certain class.

For more independent work of students in chemistry, quizzes, chemistry olympiads, games in chemistry can be organized.

Olympiads in chemistry play a special role in the in-depth development of the theoretical foundations of chemistry. Significantly increases the interest of students in chemistry, forms in them such abilities as stubbornness, attentiveness, increases the propensity for research activities.

If there are no conditions for conducting experiments (practical work and laboratory experiments) in secondary schools as independent work of students, then to increase students' interest in chemistry, excursions to industrial and agricultural enterprises near the school's location can be organized.

Unlike other subjects taught in general education schools, the use of practical teaching methods in chemistry lessons is more possible. Such methods include:

Laboratory experiments, demonstration experiments, practical work.

Laboratory classes (laboratory work) experiments conducted by students in school laboratories should form their skills of independent work, research activities. Laboratory work plays a very important role in the deep assimilation of new educational (lesson) material.

Practical work is a student experiment conducted by students according to specially compiled instructions in textbooks made on the basis of pre-prepared educational materials. Comprehension of new educational material in chemistry and obtaining new knowledge and skills is the main goal of laboratory work in chemistry. Laboratory experiments in chemistry are conducted by individual, group, and collective methods.

Laboratory work is carried out according to the following methods: interview (updating of very important theoretical knowledge in chemistry; solving emerging problems by experimental method, familiarization of students with the plan of laboratory work, answers of the chemistry teacher to questions arising from students regarding the methods of performing laboratory experiments, independent work of a student during laboratory work, improving the quality of laboratory work by addiction.

The stages of the activity of a chemistry teacher when performing practical work to be performed by students should be as follows: preparation for practical work, determination of technical and theoretical aspects of practical work, determination of the properties of chemical reactions to be performed in practical work, characteristics of the devices on which the reaction will be carried out.

In most cases, students' written reports on practical work are evaluated to verify the practical exercise performed by students. In connection with the assessment of students' practical abilities, the process of doing work for students should be carried out, in connection with which the teacher should determine which practical abilities the student will evaluate in the work that he will perform.

A distinctive feature of practical and laboratory work in comparison with lectures is that they better form the special activity and mental activity of students in the classroom. If, with the help of an explanation, the subject is taught by a lecture using the problem-situational method, then the problem finds its solution, and these differences are eliminated.

Practical and laboratory work on the in-depth development of the theoretical part of chemistry taught in our universities is becoming one of the most modern experimental methods of chemical science. The experiments conducted in our universities are distinguished by the convergence of methods of teaching science and teaching methods that are taught through laboratory work. Practical and laboratory work is carried out in order to realize the significance of an event in a person's life.

According to the theory of the phased formation of the student's mental activity, practical and laboratory work can be

applied to new knowledge by passing through materialized activity. Literally, this means that the assimilation of knowledge occurs through the processing of educational material with hand movements. Sometimes practical and laboratory work is carried out after all the lecture topics in the subject or after several of its topics, and sometimes vice versa-until the lecture. Both of these two options are not relevant to the goal in didactics. The placement of practical and laboratory works before the lecture form of teaching in the chain of teaching organization is applied according to the general principles of the methodological approach to the method of understanding the subject and contributes to the attempt to increase the student's understanding activity, and the problem of laboratory work is solved with the new knowledge gained in the

Practical and laboratory work, in comparison with lectures and seminars, has more didactic capabilities as an element of the training and education system. Considering that laboratory and practical work are placed at the 4th stage of the formation of mental activity, in fact, this form of teaching includes all levels of assimilation of knowledge and combines many educational functions.

One can say the very positive roles of practical and laboratory work in the formation of the student's personality. This includes student skills such as freedom from self-doubt, as well as the development of a sense of Solidarity, freedom, faith in one's own strength, decisiveness.

It is speech that unites people in a collective, and it directs the activities of people in a collective, so speech is an indicator of the knowledge acquired by a person, or knowledge itself. In class, students need to be allowed to speak, not to babble. Or, in the conditions of laboratory work, allow the student to speak, create an environment in which he can criticize the teacher in a friendly way, express thoughts that the teacher did not say exactly during the work performance, criticize the authors of lessons and teaching aids, tell the shortcomings of the textbook, inaccurate ideas, mistakes. The teacher himself must be allowed to participate in this process. Then, in the process of the lesson, even students cannot say anything to the teacher's address. At present, in order to modernize and enrich the

laboratory practical with the help of thought-provoking, creative chemical means, it is necessary to use modern chemical methods, highlighting practical works with modern technical means, computerization of practical works, corresponding to the content of teaching, practical works.

In the first paragraph of Chapter II of the dissertation, methods for developing the mental activity of students in teaching chemistry are indicated. The formation of the ability of students to develop their mental activity, to use its capabilities as much as possible, to creatively solve the problem that arises before them is the main goal of developmental training. On the basis of this, the student not only solves the problem facing him, but also determines the method of solving a similar problem that he will face. The main thing is that the student independently acquires new knowledge on the basis of the knowledge known to him, and also has established himself.

In the process of mastering knowledge, developmental training takes place.

In the chemistry course, the student acquires knowledge related to substances and chemical reactions, which are the object of study of Chemistry, explains the patterns of chemical reactions and their essence, learns concepts and theories related to chemistry.

In the process of such acquisition of knowledge, all elements of mental activity are realized, the material studied is comprehended, knowledge is acquired, and as a result, the basis of developmental learning is created.

A prerequisite for students to think creatively independently is an understanding of the importance of solving the problem that has arisen. In this process, all elements of analysis, synthesis, generalization, systematization, abstraction are used.

When he does not have the ability to analyze the information he needs when receiving training, his interest in training decreases, and ultimately the subject taught (chemistry) becomes uninteresting to him.

As they analyze the essence of traditional phenomena and chemical facts, the mental activity of students develops, long-term knowledge is acquired.

In order to realize the above, problem solving is of particular

importance in the process of teaching chemistry. Solving a problem from chemistry is a means to achieve the goal of studying chemistry. In the process of solving problems from chemistry, all parts of mental activity are used with research, interdisciplinary integration is performed.

Ways of teaching chemistry experiments with problem Learning Methodology as independent work of students in secondary schools are shown.

Currently, the main goal of teaching chemistry in general education schools is the formation of students as individuals.

And this goal can be achieved by activating the independent activity of students in the learning process. That is, the student independently analyzes the practical material, acquires new knowledge and skills related to chemical phenomena using previously acquired knowledge, makes comparisons and generalizations.

It is impossible to achieve a good result in teaching chemistry without active comprehension activities of students. A chemistry teacher should attend the lesson as an organizer of students ' comprehension (comprehension) activities. And this can be achieved by using various types of training technologies. This is training technologies, problematic, interactive training, computer technologies, etc. it may be that their goal is to activate the learning activities of students. Since the object of the subject of chemistry is matter and the material world, there are ample opportunities for using Problem-Based Learning Technologies of laboratory and practical work in teaching chemistry. Therefore, the technology of problem learning can be used to activate the cognitive activity of students in Chemistry Lessons.

In the problem learning method, a chemistry teacher can always connect students to problem solving, because problem learning is developmental learning. When a chemistry teacher applies a problem-based learning method, students do not have an explanation of the new material, they work on the material independently.

Since chemistry is an experimental subject, the basis of the teaching of chemistry is the source of chemical knowledge, their control, the promotion, approval of ideas and a chemical experiment based on them.

Chemistry experiment is a didactive tool in achieving the main goal of the training. Through the solid interaction of theory and experiment from chemistry, students can gain in-depth knowledge and skills, and these skills can be developed. When systematically using an experiment (laboratory and practical work) in chemistry training, students ' ability to observe chemical facts and phenomena is formed, and they interpret these phenomena on the basis of chemical theories and laws.

The application of a problem situation to the formation of the ability to solve conflicting problems in students creates good conditions.

The third paragraph of Chapter II outlines ways to use creative-problematic tasks in the process of forming the mental activity of students.

The activity of students in teaching chemistry can be divided into material and materialized. As the name implies, the object of understanding in a material activity is a real chemical process and concrete chemicals.

Material activity is carried out in Chemistry Lessons directly in the process of performing experiments. In this case, the experiments are carried out by the teacher or the students themselves.

The basis of teaching chemistry is the student's activity of conducting experiments. Not to mention the successful teaching of chemistry without practical experience. Otherwise, chemistry would have turned into, as many say, “chalk chemistry”.

Based on what has been said, We widely use problematic-creative tasks that are directly related to people's health and everyday life. As they solve such problematic-creative tasks, students understand the role of chemistry in the life of different peoples and the chemical nature of life processes**.**

The fourth paragraph of Chapter II describes the role of independent work of students in the process of teaching chemistry. In general education schools, students have the following forms of independent work:

- teaching-research work, linking chemistry training with life.
- problem learning; develops independent and creative thinking

of students.

- laboratory exercises, develops research activities of students.

- the organizer of the preparation of projects, the awareness activity of students.

- in the process of preparing a report, students independently demonstrate the knowledge and Skills received by preparing a report on the educational unit.

- solving problems and exercises from chemistry is the process of reflecting the theoretical knowledge that students receive.

Research activity of pupils: research activity of pupils contributes to the development of their creative activity, as well as to the solution of some educational issues, in particular, to strengthen their position in the team. This activity can also be interdisciplinary and interdisciplinary integrative. Students ' ability to conduct independent research, come up with certain ideas and test these ideas in practice can be developed in Chemistry Lessons and extracurricular work.

The research activity of students can be formed in the following stages. Student:

- Observes chemical phenomena;
- Analyzes the events on a scientific basis;
- Establishes assumptions and provisions about the incident;
- Develops the methodology for the occurrence of the event;
- His practical work on the incident is evaluated.

In educational-research activities, the student realizes the truth about the chemical phenomenon. The following applies to the educational-research activities of students:

- ability to put forward a problem about a chemical phenomenon;
- ability to make assumptions about the event;
- ability to observe the event;
- ability to perform practical work on the event;

The main form of Organization of research activities of students is a lesson. The chemistry teacher uses modern pedagogical technologies based on the research method of teaching. The research method of training is aimed at the acquisition of new knowledge by

students and the formation of certain skills in them.

The importance of research activities for students includes:

a) significant aspects of chemical phenomena are identified and studied;

b) accurate and reliable information about chemical phenomena is obtained;

c) the knowledge gained by students is consolidated and creates the necessary conditions for applying them in practical life.

In the process of teaching chemistry, the project method is considered one of the most effective methods in the formation of research activities of students in the lesson and in extracurricular activities.

In chemistry lessons, students must have the most necessary knowledge and skills in order for them to start working with the project method. Students on projects must have the following skills and qualifications to practice research activities:

1) the habit of comparing:

- to identify similarities and differences of physical and chemical phenomena;

- to compare the phenomena that occur when you pour potassium-nitrate into one of the cups with distilled water inside, and solid sulfuric acid into the other by shaking it drop by drop.

2) ability to identify relationships between cause and effect:

- ability to explain why a neutral atom is electroneutral;

- the ability to analyze what chemical acids occur when a neutral atom receives and gives electrons.

3) ability to classify chemicals:

- the ability to classify oxides, bases, acids, salts.

4) ability to analyze substances by composition:

- how to experimentally determine the presence of a phosphate ion in a sodium-orthophosphate solution?

- how to prove the presence of a potassium-sulfate mixture on the example of copper (II) chloride?

5) generalization is the activity of replacing the main conclusion with a general provision.

- draw a general conclusion explaining the formation of a white

precipitate when you add silver (I) nitrate to individual test bottles containing copper (II) chloride, hydrochloric acid, zinc-chloride solutions;

- draw a general conclusion explaining the discoloration of brominated water when ethylene, propadiene are released from a test bottle containing brominated water.

Thus, the above confirms how important the research activity of students is in mastering chemistry.

In the fifth paragraph of Chapter II, methods for independent implementation of practical and laboratory work by students are given. In practical and laboratory work, the frontal (flow) method is used to complete the task, in which all students perform the same practical work. For the frontal implementation of practical work, devices of the same type are used. If practical work is carried out in groups, the number of required devices is reduced by 2-5 times, due to which new more expensive modern devices can be purchased in the chemical laboratory.

The itinerary method in the implementation of laboratory and practical work is that when students perform various exercises by switching from one device (device), i.e. from one desk to another on the itinerary (graphic), then it is recommended to provide the chemistry laboratory with single devices. Nevertheless, practical and laboratory work based on new research methods requires serious preparation for simultaneous execution with lectures and seminars. Clean, tidy, tables covered with plastic materials, modern devices for students to perform practical work, bright lighting, moving air towel, chalk board, modern calculating machines, periodic table of chemical elements, table of fixed numbers for performing chemical calculations, etc. it has a strong influence on the quality performance of practical work, has a huge impact on creating creative conditions in the educational process.

Considering that the student wants to join practical work with high enthusiasm and speed, but the unlimited amount of time devoted to the implementation of practical work creates an excellent psychological environment in the laboratory, and practical work results well. After the practical work is completed, each student must hand over his desk to the teacher, and not to the laboratory assistant (which sometimes happens).

For this to be known, it would be good for students to write in a laboratory journal or record in a practice Journal. Practical and laboratory work is considered completed only when the place where students work is the same as in the case when practical work has not begun. This should be a mandatory rule that will be given to students in the first practical and laboratory work. This should also have a very strong impact on the subsequent practical work of those who study during practical work. The most important element of laboratory and practical work is the composition of the report of the executed work and the filling out of the laboratory Journal. Despite the collective execution of practical and laboratory work, the laboratory Journal must be filled out strictly individually.

The sixth paragraph of Chapter II describes the role of independent work of students in the acquisition of theoretical knowledge in chemistry and the formation of skills. It should be noted that the current required general education standards are relevant and educational in the educational process, as well as a systematic and creative approach to the educational process. The main way to apply this approach in education is the form in which students from chemistry carry out independent work.

At the end of the full study of a particular subject in chemistry in any of the VII-XI grades of general education schools, practical work on chemistry should be carried out in order to consolidate and systematize students ' knowledge in chemistry, as well as to form and develop practical skills .

Students can achieve great success in the study of Physico-Chemical Properties of chemicals, methods of their obtaining by carrying out independent work in chemistry. When they devote a lot of time to independent studies from chemistry, students can acquire enough knowledge and skills that they will need in their independent lives. The knowledge and skills they can acquire will help students spend less time preparing reports on the profession (art, specialty) they may receive in after-school life. The number of verification questions independently performed by students and the number of practical work to be performed independently are controlled by the teacher. Independent work of students in chemistry is carried out

with various goals. A large part of them, as well as the study of methods for obtaining physico-chemical properties of chemicals, should be related to the topic of study to be taught new.

In the **first paragraph of Chapter III** of the dissertation, which is called the methods of preparing abstracts and solving problems in chemistry as an independent work of students, examples of students preparing reports on various topics in chemistry are given. In the **second paragraph of Chapter III**, examples of the preparation of reports on the units of teaching chemistry as an independent work of students are given.

Abstract concerning the unit of instruction of the first concepts of chemistry

Chemistry is the science of substances, their properties and transformations.

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What physical bodies are made of is called matter.

↓ ↓

The composition of the substance is divided into two parts.	Substances consist of atoms and molecules.	The signs that distinguish one substance from another are called its properties.

Simple substances consist of atoms of the same type.	Complex substances consist of various types of atoms.	An atom is the smallest chemically indivisible particle of a substance.	A molecule is the smallest particle of a substance that contains its composition and properties, and it is chemically divisible.	The transformation of one substance into another is called chemical properties.	Physical properties of the substance: aggregate state, color, odor, density, t_{bol}, $t_{mel.}$, solubility, electrical and thermal conductivity.

↓ ↓ ↓

Recording the composition of a	The value showing how many times the	The value that shows how many times a molecule of a substance is

substance with chemical signs and indexes is called a chemical formula. Chemical sign	mass of an atom of a chemical element is heavier than 1/12 of the mass of a carbon atom is called the relative atomic mass (A_r).	heavier than 1/12 of the mass of a carbon atom is called the relative mass of the molecule (Mr). To calculate it, the number of elements in a substance is multiplied by A_r and summed up. For example, $M_r(Na_2CO_3)=2.23+1.12+3.16=106$

The changes that occur in the environment around us are called events.

↓ ↓

<table>
<tr><td rowspan="2">A physical event is an event that occurs when a new substance is not extracted from a substance. As a result of such phenomena, the size and shape of the object, its aggregate state change. Examples of physical phenomena include melting, freezing, evaporation, distillation, condensation, sublimation, crystallization, etc.</td><td colspan="3">The phenomena observed when a new substance is obtained from another substance are called chemical phenomena. Chemical phenomena include gorenje, fermentation, decomposition, electrolysis, hydrolysis, photosynthesis, cracking, corrosion, etc.</td></tr>
<tr><td>It is observed with the following signs:
- color change
- change of smell;
- formation or dissolution of sediment
- separation or absorption of gas
- release or absorption of energy.</td><td>Obeys the law of conservation of mass. The sum of the masses of the substances entering the reaction is equal to the sum of the masses of the substances formed.
$m_{(basic\ substances)\ total} = m_{(product)\ total}$.</td><td>Chemical phenomena are expressed by quantitative equations. The recording of chemical reactions by chemical formulas and coefficients is called a chemical equation. For example,
$Na_2O + H_2O \rightarrow$
$\rightarrow 2NaOH$</td></tr>
</table>

Quantitative quantities in chemistry

Quantity and its designation	**Concept and definition**	**Unit of measurement**
Amount of substance (v)	This is a value that gives an idea of the number of structural particles in a given part of the substance. 1 mol is the amount of a substance containing as many structural particles (atoms, molecules, ions) as the number of structural particles in 12 grams of a carbon atom.	mol, kmol, mmol

Avogadro Constant (N_A)	1 mole is a quantity that shows the number of particles in a substance.$N_A = 6{,}02 \cdot 10^{23}$	1/mol; mol^{-1}
Number of particles (N)	$N = v \cdot N_A$	No
Molar volume (v_m)	This is the mass of a mole of a substance in grams. In numerical terms, it is equal to the relative mass of a molecule (atom). $M = m/v$; $M = [M_r]$; $M = [A_r]$	g/mol
Relative gas density	This is the amount that shows how many times lighter (heavier) one gas is than another. In other words, it shows how many times the density of one gas is heavier (lighter) than the density of another gas.	No
Mass fraction of the element (ω)	$\omega = A_r(El).n / M_r \cdot 100\%$ где n - количество атомов, массовая доля которых вычисляется в молекуле.	No
The mass fraction of the dissolved substance in the solution (mixture).	İn solution: $\omega = m_{h.m} / m_{sol.} \cdot 100\%$ İn nixture: $m_{(mix.)} = m_1+m_2+m_3 ...$ $\omega = m_1 / m_1+m_2+m_3 ... \cdot 100\%$ $m_1+m_2+m_3$ – the mass of the components in the mixture.	No
Molar density (C)	$C = v/V$; v – is the number of moles of the solute, V - is the volume of the solution (in liters).	mol/l
Volume fraction of gas in the gas mixture	$V_{(mixture)} = V_1+V_2+V_3 ...$ $\omega = V_1 / V_1+V_2+V_3 ... \cdot 100\%$	No

In the third paragraph of Chapter III, a form is given for preparing a report on the phenomenon of isomerism as an independent work of students.

Isomers

↓ ↓

Structural isomers	Stereoisomers
The molecule has the same molecular formula, but their structural formulas are different	The molecule has the same formula of structure, but the arrangement of atoms in space is different.

↓ ↓

Geometric isomerism Optical isomerism

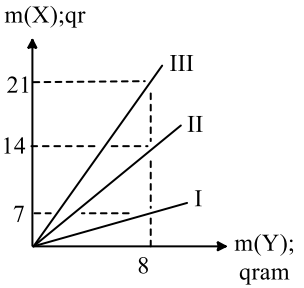
In the fourth paragraph of Chapter III, the methods of solving problems related to the basic concepts of chemistry, amount of matter, Avogadro's law, periodic law and periodic system, and the structure of the atom are shown.

A task. Determine the aggregate state of substances at 60^0C**.**

Substances	$T_{mel.}{}^oC$	$T_{boil.}{}^oC$
X	+10	+120
Y	-20	+40
Z	+30	+130

Solution: Any substance is solid up to its melting point, liquid between melting point and boiling point, and gaseous after boiling point. Then at 60^0C, X-liquid, Y-gas, and Z-liquid exist.

A task.



If the formula of compound III is X_3Y_2, determine the formula of compound I and II.

Solution: in the combination X3Y2, according to the graph, it becomes 3x = 21; x = 7; 2y = 8; y = 4. Then the combination I XY_2 becomes the combination II XY.

.

7 4·2=8 7 4

14 8

Answer: I. XY_2; II. XY

In the fifth paragraph of chapter III, methods for solving non-standard tasks, such as independent work of students, are given.

A task. With the complete combustion of an unknown substance, 3.6 ml of water and 2.24 liters of nitrogen (in n.w.) are formed in oxygen. The relative vapor density of this unknown substance in relation to hydrogen is 16. Determine the chemical formula of this substance, what are its properties can be called?

Solution: Mr=2•D_(H_2)=2•16=32; M=32 g/mol. This substance can contain either one oxygen atom, or completely absent.

If water and nitrogen were taken during combustion, then H and N must be present in the composition of the substance. 3,6 ml H_2O=3,6 qr H_2O. $\nu(H)=2\nu(H_2O)=2\cdot\frac{3,6}{18}$=0,4 mol. $\nu(N_2)=\frac{2,24}{22,4}$=0,1 mol N_2; then the simple formula of the substance will be NH_2. M_r (NH_2)=16. Since the M_r of the substance is 32, the actual formula of the substance will be N_2H_4.

N_2H_4-called hydrazine, it is a colorless liquid at room temperature.

The sixth paragraph of chapter III explains the role of independent work of students in obtaining theoretical knowledge in chemistry and the formation of skills and abilities.

In the seventh paragraph of chapter III, methods of teaching oxygen subjects using modern teaching technologies are given.

The eighth paragraph of chapter III sets out ways to evaluate the effectiveness of teaching chemistry based on the independent work of students.

Activity is understood as the existence in consciousness of knowledge about the object itself, in the form of images, representations, operations, concepts, a mental form of activity. The knowledge that can be included in the mental plan is the acquired knowledge of a higher quality.

Generalizing activity is characterized by the available size of the allocation due to the realization of non-existent properties of the object. By the number of selected features of an object used, its quantitative assessment is determined.

With all the primary signs performed by a person, a wide-open activity that is part of the activity is closely related. The less the operation is performed, the narrower the disclosure of the operation becomes.

Consider how, in the process of composing the hydrolysis reaction equation, the number of operations for composing a short ionic reaction equation decreases.

I. How the activity is revealed at the beginning of the educational process, as well as in a very poor acquisition of knowledge.

1) $Na_2CO_3 \rightleftarrows 2Na^+ + CO_3^{2-}$; 2) $H_2O \rightleftarrows H^+ + OH^-$

3) $CO_3^{2-} + OH^-$ = impossible; 4) $Na^+ + H^+$ = impossible;

5) $Na^+ + OH^-$ = NaOH (strong electrolyte)

6) $Na^+ + OH^- + H^+ = NaOH + H^+$

7) $CO_3^{2-} + OH^- + H^+ = HCO_3^- + OH^-$

8) $CO_3^{2-} + H_2O = HCO_3^- + OH^-$ (purpose of the activity)

II. One of the possible explanations of the action.

1) $Na_2CO_3 \rightleftarrows 2Na^+ + CO_3^2$

2) $H_2O \rightleftarrows H^+ + OH^-$

3) $CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^-$

III. Accurate disclosure and description of the activity.

1) $CO_3^{2-} + H_2O \rightleftarrows HCO_3^- + OH^-$

Thus, in the above example, there was a reduction in activity from 8 operations at first to 3, and at the end to 1, depending on the degree of comprehension of this material. Not to mention the fact that the teacher should value more the knowledge of the one who expresses the equation, evaluating the student's answer to the question.

In the ninth paragraph of chapter III, the significance of the teacher's observation when checking practical skills in chemistry is analyzed in detail.

Let's consider the importance of several types of independent work of students for the disclosure of their knowledge, practical skills and abilities.

I. Verification when performing independent work. To test knowledge, skills and abilities, independent work of students with a book is of great importance in the lesson.

One of the methods of testing both the knowledge and the fixed knowledge of the student in chemistry is based on the fact that he answers questions and independently draws up a plan, pictures, drawings, graphs, diagrams of what he has read. Here is an example of a number of tasks to test the student's knowledge after independent work with the textbook. With the help of a drawing, you can invite a student of the VII class to talk about the use of oxygen in a gaseous and liquid state.

A student of the eighth grade can be offered to do the following independent work with the book: study the classification of chemical

reactions, make a conversation plan on this topic.

To offer students of the IX class to build a scheme for the use of sulfur in industry.

II. Knowledge testing when students perform laboratory work.

Verification and evaluation of laboratory work are carried out on the basis of observing the practical work of students and answering questions. Here is an example of a lesson on the topic "chemical properties of sulfuric acid" in the IX class.

The teacher writes the topic of laboratory work on the blackboard, sets attention to the rules of working with reagents, the cleanliness of the laboratory table, explains the purpose of the work and writes the task on the blackboard.

Experiment 1. Pour a little litmus solution into a test bottle and add 3-4 ml of sulfuric acid.

Experiment 2. Pour sulfuric acid into a test bottle and add a piece of zinc on top. Turn it on to check the purity of the released hydrogen.

Experiment 3. Take some copper (II) oxide into a test bottle and add sulfuric acid to it, heat the test bottle.

Experience 4. Take the NaOH solution in a test bottle and fill it with sulfuric acid.

Experience 5. Take a little barium chloride solution in a test bottle and add sulfuric acid to it.

Experiment 6. Pour a little sodium carbonate solution into a test bottle and add sulfuric acid.

The teacher addresses the class with the following questions: what is the purpose of our first experience? The named student talks about how to complete the task. After that, when all the students finish the task, the teacher gives them the task to put the test bottles on a tripod. He asks these students again, "What did you observe during the reaction? Why has the color of the litmus changed? What substances are called indicators? What conclusion can be drawn from this experience?"

Drawing conclusions, the teacher gives the task to write down the result in the students' notebook and, explaining the second experience to the students, asks the following questions: "What is the

purpose of this experience?"Calling the next student to the blackboard, he asks how he will perform the assigned task. The student fulfills it.

The teacher asks the class, "What did you observe? What conclusion can be reached? One of you write the reaction equation on the blackboard. What substances are called salts? Then he invites students to write down the result in their notebooks.

The teacher begins to explain the following task: “What is the purpose of the experiment? The teacher asks the third student how to complete the task. The student explains the rules necessary during the execution of a given task. After the experiment, the teacher calls this student to the blackboard: “What did you observe during the experiment? Write the reaction equation on the blackboard." In another experiment, this is done in a sequence of plans.

Then the teacher instructs the students to take notes and put the notebook away.

In conclusion, he asks questions to summarize the whole work: what substances does sulfuric acid react with? What general conclusion can be drawn about the chemical properties of solid sulfuric acid?

At the end of this lesson, the teacher can write an assessment to six students for their work as a result of observation and based on their answers on the blackboard.

In the tenth paragraph of chapter III, the ways of organizing and conducting a pedagogical experiment in secondary schools on the independent work of students in chemistry are given.

In connection with the study, the following results were obtained.

The importance of independent work that students can do in chemistry in grades VII-XI of secondary schools, scientific and pedagogical research that we systematically conduct in the field of identifying problems that arise during chemistry teaching, their solutions and the impact on the quality of knowledge that students can get in chemistry, allowed us to obtain the following general results.

1. For the first time, we created a system for organizing and

conducting independent work of students in chemistry in order to build chemistry lessons in accordance with the requirements of the time and increase their effectiveness.

2. By organizing and carrying out independent work of students in chemistry, the content of the chemistry course of secondary schools was enriched in accordance with the level of development of the science of time and chemistry. In addition, the methods of conducting laboratory work (classes), organizing and performing practical work that can be attributed to independent methods of students' work in chemistry are defined.

3. Independent work of students in chemistry the essence of the problems of education in the process of learning with labor education that they can achieve is revealed, methods and means of realizing the possibilities of students in life to find them are investigated.

4. The methods of organizing and implementing independent work of students in chemistry are defined in order to study their deep assimilation of knowledge in chemistry, the ability to compare, reason, apply, coordinate.

5. A new learning environment has been formed, created using methods of organizing and implementing independent work of students in chemistry.

6. It is established that during the organization and implementation of independent work of students in chemistry in the learning process, interest in the subject of chemistry increases among poorly trained students.

7. Resources intended for the organization and implementation of independent work of students in chemistry, with their effective use in deepening students' knowledge, affect the development of students' memory, attention, logic and the speed of assimilation of information related to knowledge.

8. Independent work of students in chemistry creates a favorable system between the practical part of chemistry and its theoretical foundations.

9. When resources prepared for the organization and implementation of students' independent work in chemistry are effectively applied to deepen student knowledge, they affect the

development of memory, attention, logic, and the speed of perception of information related to knowledge in students.

10. Students' independent work in chemistry creates a favorable system between the practical part of chemistry and its theoretical foundatio**ns.**

The main results of the dissertation are reflected in the following articles:

1. Makhmudova, A.C. Report form on the phenomenon of isomerism as an independent work of students // Chemistry at school. Scientific-theoretical and methodological collection, - 2019. № 2 (66), - p. 15-21.

2. Abbasov, M.M., Mahmudova A.D., Abbaszade S.M. The role of independent work of students in the process of teaching chemistry // Pedagogical Sciences, Moscow: – 2019. №6 (99), – p. 18-22.

3. Makhmudova, A.C. Teaching experiments in chemistry as independent work of students in secondary schools with problematic teaching methods // chemistry at school. Scientific-theoretical and methodological collection, – 2019. № 3 (67), – p. 4-9.

4. Alieva Sh.R., Abbaszade S.M., Makhmudova A.C. Methods of developing students' mental activity when teaching chemistry / / chemistry at school. Scientific-theoretical and methodological collection, – 2019. № 3 (67), – p. 47-50.

5. Makhmudova, A.C., Alieva Sh.R., Musayeva G.M. Teaching the topic of oxygen using modern teaching technologies // Chemistry at school. Scientific-theoretical and methodological collection, – 2019. № 3 (67), – p. 51-54.

6. Makhmudova, A.C. The role of independent work of students in teaching chemistry in secondary schools // International scientific conference dedicated to the 90th anniversary of the Institute of Petrochemical Processes named after Academician Yu G Mammadaliev ANAS, on the topic ”Current Problems of modern chemistry", Baku, – October 2-4, - 2019, - p. 508-509.

7. Makhmudova, A.C. Preparation of abstracts on educational units of chemistry as an independent AI of students // chemistry at school. Scientific-theoretical and methodological

collection, – 2019. № 4 (68), – p. 46-56.

8. Makhmudova, A.C., Zulfugarova, A.V., Abbaszade, S.M., Abbasov, M.M. Ways of using creative problem tasks in the process of forming the mental activity of schoolchildren // III All-Russian scientific and practical conference "Education, upbringing and pedagogy: traditions, experience, innovations", Russian Federation, Penza, – September 25, - 2020, p.13-16.

9. Nurieva, M.S., Abbasov, M.M., Makhmudova, A.C. Methods of modeling the teaching of chemical kinetics in secondary schools / / Materials of the II Republican Scientific conference “Fundamentals of humanities and social sciences", – Baku, – December 22, - 2020, – pp. 69-71. DOI: 10.36719/2663-4619/22.12.20/02/69-71.

10. Makhmudova, A.C. Methods of solving non-standard questions of students as independent work // Baku University for Girls. Scientific papers, – 2021. Volume 12, No. 1 – - p. 200-204.

11. Makhmudova, A.C. The significance of a teacher's observation when checking practical skills in chemistry // chemistry at school. Scientific-theoretical and methodological collection, – 2021. № 2 (74), – p. 68-76.

12. Abbasov M.M., Nurieva M.S., Makhmudova A.C. Implementation of developmental learning in the process of solving problems in chemistry // Nauka-praktiki. The material of the II International Scientific and Practical Conference, Belarus, Baranovichi: – May 13, - 2021, – part 2, – p.227-228.

13. Makhmudova, A.S. An example of students preparing reports on various topics of chemistry // Institute of Education of the Republic of Azerbaijan, Scientific Works, - 2021. Volume 88, No. 4, - p. 141-145.

14. Makhmudova, A.C. The role of independent work of students in the acquisition of theoretical knowledge and the formation of skills in chemistry // Actual nutrition of humanities. – 2022. No. 56, volume 2, – p.200-205.

15. Makhmudova, A.C. The role of independent work of students in obtaining theoretical knowledge in chemistry and the formation of skills and abilities // Baku University for

Girls.Scientific papers, – 2022. Volume 13, No. 3 – - p. 117-121

16. Abbasov, M.M., Mahmudova A.C., Abbaszade S.M. Methods of solving experimental problems in chemistry as independent work of students // Institute of Education of the Republic of Azerbaijan, scientific works, – 2022. Volume 89, No. 4 – p. 204-207

17. Makhmudova A.C. Methods of independent performance of practical and laboratory work by students / / chemistry at school.Scientific-theoretical and methodological collection, – 2022. № 3 (79), – p. 41-46

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20. Makhmudova A.J. The Importance of Teacher Observation in Assessing Students' Practical Skills and Competencies. In: Problems of Humanities and Education in the Modern World: Collection of Scientific Articles Based on the Materials of the 10th All-Russian Scientific and Practical Conference with International Participation, Republic of Bashkortostan, Sibay, 22 November 2024, pp. 123–125.

21. Makhmudova A.J. Methods of Independent Student Performance of Laboratory Assignments in Chemistry Teaching. In: The Digital Future of Science and Education: Trends and Prospects: Collection of Scientific Papers, Kazan, 2024, pp. 44–48.

22. Mahmudova A.J. Assessment of the Pedagogical Effectiveness of Chemistry Teaching in the Context of Students' Independent Learning Activities. Ministry of Science and Education of the Republic of Azerbaijan, Azerbaijan State Pedagogical University, Academician Yusif Mammadaliyev Institute of Petrochemical Processes, Nakhchivan State University. Proceedings

of the Republican Scientific Conference “Chemistry, Technology, Ecology,” dedicated to the 120th anniversary of Academician Yusif Mammadaliyev. Baku, 25–26 November 2025, pp. 515–517.

23. Mahmudova A.J. Methodology for the Formation of Experimental Skills among Students in the Teaching of Chemistry Lessons in General Education Schools. Scientific Works of the Institute of Education of the Republic of Azerbaijan, 2025, Vol. 92, No. 5, pp. 90–93.

24. Mahmudova A.J. Implementation of Laboratory Work as a Form of Independent Student Activity in the Teaching of Chemistry Lessons in General Education Schools. Scientific Works of the Institute of Education of the Republic of Azerbaijan, 2025, Vol. 92, No. 6, pp. 196-199.

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