



The Role of Virtual and Non-Standard Laboratory Experiences in the Development of Student's Independent Work Skills

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ABSTRACT

This article provides information on how students in chemistry classes can conduct chemical experiments with information and communication technologies, understand new material, conduct experiments with toxic chemicals, and use rare and expensive reagents in desired quantities. In addition, it is thought that such tasks as strengthening the studied topic and drawing independent conclusions from the results of experiments can be mastered in a short time.

It also highlighted the importance of non-standard laboratory experiments with substances used in life in developing students' independent work skills in chemistry lessons in secondary schools

Keywords:

Chemist, profession, doctor, interest, enthusiasm, quality education, knowledge, skills and creativity, short time, laboratory, virtual laboratory, information technology, acid, conclusion, performance, modeling, safety, non-standard, creative activity, development, candle, coal chemical reaction, comprehensive school, experience, understanding

It is important to disabuse students of the idea that knowing chemistry only means becoming a chemist and to instill in them the idea that chemistry is of special importance in the context of several other important professions. In particular, it is important for the educational process to form in students the ability to acquire such important professions as doctor, dentist, pharmacist, agronomist, ecologist, technologist, and biologist by mastering the science of chemistry. Learners develop an interest in the listed professions and this, in turn, increases their desire to master the subject very well in order to become a profession of their choice. In order to realize these interests, a student of a general education school is required to try to get independent knowledge even outside the classroom.

Among the sciences, chemistry is distinguished by its unique chemical experiments. In order for the student to perform these experiments independently, it is necessary to have well-developed knowledge, skills and creative abilities. The reason for this is that a little carelessness during chemical experiments can lead to various disappointments, which in some way reduces students' interest in science. It is important to increase enthusiasm for science by various methods in developing students' ability to work independently in chemistry classes, because where there is enthusiasm, there is quality education.

Conducting laboratory experiments using information and communication technologies in chemistry classes for students of general education schools greatly helps to increase the

creative activity of students and develop independent work skills [1].

Some general education schools do not have enough chemical equipment and reagents to perform the laboratory experiments given in the plan. More laboratory experiments are needed to increase students' interest in chemistry. Even when there are enough reagents, the student's time allocation prevents him from performing laboratory experiments aimed at obtaining independent knowledge. For this reason, it is not possible to complete some experiments, write the conclusions of the experiments, and to them in the specified time to strengthen the topic. This is the main obstacle to students not forming the necessary knowledge and skills.

According to the decision of the President of the Republic of Uzbekistan No. PQ-4805 of August 12, 2020, Annex 5, paragraph 19, part two, "virtual laboratories" will be included in the educational process in higher and professional educational institutions starting from the 2021-2022 academic year. Phased implementation tasks are defined [2]. It is natural that the task of this decision will be implemented in general education schools and used in chemistry teaching. Students who can independently use virtual laboratories in computer programs during school, achieve high results in professional and higher education institutions.

Students in chemistry classes can conduct chemical experiments with information and communication technologies, understand a new material, conduct experiments with toxic chemicals, use rare and expensive reagents in any amount, strengthen the studied topic, and draw independent conclusions from the results of experiments. They will understand such tasks completely and in a short time.

The advantage of teaching schoolchildren to perform laboratory experiments in computer programs is that they will have the opportunity to conduct laboratory experiments virtually without test tubes and chemicals. For example, the lab experiment shown in Figure 1 takes very little time to complete. An equal amount of CaCO_3 was placed in all test tubes,

and HCl solutions of different concentrations were poured into each of them. As it can be seen from the experiment, it is not difficult to understand that the amount of carbon dioxide in the test tube with the concentration of hydrochloric acid is higher than the volume of the balloon. For example, $\text{CaCO}_3 + \text{HCl} = \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$

Through the experiment performed with this computer program, the learner develops knowledge about gas evolution reactions, dissolution of precipitates in acid, the dependence of chemical reaction rate on concentration, ion exchange and neutralization reactions. In chemistry textbooks, "Types of chemical reactions" taught in the II quarter of the 7th grade, "Preparation and properties of acids" taught in the IV quarter of the 7th grade, "Reversible and irreversible reactions" and "Reaction rates" taught in the III quarter of the 11th grade understanding of They also serve as laboratory experiments that satisfy the topics "Factors affecting the rate of reaction"



Figure 1. The reaction of calcium carbonate with different concentrations of hydrochloric acid in a virtual method.

Conducting classes using computer programs in the educational process helps to achieve the following achievements:

- to involve all students in the lesson process by making the lesson more interesting and demonstrative
- elimination of the need to purchase expensive equipment and jets
- the possibility of modeling experiments that are impossible to conduct in laboratory conditions

- observation of experience in a short period of time
- the safety of the chemical laboratory
- possibilities of using the virtual laboratory in independent and distance education.

The main purpose of using virtual laboratories in chemistry classes is to achieve a new quality in education, to observe experiences and changes in a short time and to draw conclusions. If the educational processes are carried out by these methods, they will serve to further increase the independent learning skills and creative activity of schoolchildren, as well as the literacy of our future generations [3].

Nowadays, the field of chemistry is developing rapidly all over the world. Due to this, with the increase in population, the demand for chemical and synthetic products to meet their needs is increasing by itself, and meeting this demand can be achieved through the development of chemical industries [4]. The task of today's reforms is to prepare students of general education as very strong, deep-thinking, and potential personnel who know their chosen direction in depth [5]. For this, it is important to organize chemical experiments with students in schools and introduce them to the educational process.

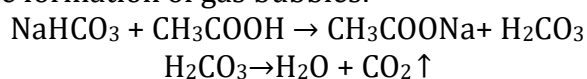
It is known that laboratory experiments are a form of work aimed at checking the knowledge, skills, and abilities acquired during the study of separate topics and departments in chemistry classes. Laboratory work reflects not only the student's theoretical knowledge, but also allows checking his mental activity, independence, ability to concentrate, creativity, and imagination. In addition, laboratory work allows the teacher, who is looking for new approaches and methods in teaching students, who is trying to interest them and attract them to study science, to demonstrate his skills and methodological literacy.

Those who study chemistry in schools do not understand the essence of experiments based on chemical reactions used in everyday life. Therefore, it is appropriate to conduct non-standard laboratory exercises with various chemicals used in life in chemistry classes in

secondary schools. In chemistry lessons, it is necessary to form knowledge and skills for students about the fact that various chemical products used in life are actually based on chemical reactions. For example, when baking soda is dissolved in boiling water, the following reaction occurs: $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$

Most non-standard laboratory experiments can be performed with chemicals used in everyday life. For example, experiments in the chemistry textbook with vinegar, lemon, malic acids, table salt, baking soda, washing soda, nitrogen, potassium, phosphorus fertilizers, pharmacy ethyl alcohol, iodine and other substances can be conducted with the participation of students. When conducting experiments with these and other substances used in life, the learner clearly understands the essence of the work, is able to perform it, and forms the ability to independently explain his opinion based on the results of the experiment. For example, coal can be obtained by burning a candle. For this, a piece of heat-resistant glass is held on the burning part of a burning candle, as a result of which the surface of the glass darkens, or when the piece of glass is held higher, it is possible to see drops of re-condensed water on the surface of the glass. A candle is a household item made of organic substances. By showing this single candle burning, it is easy to explain to students that burning organic matter produces water and carbon dioxide.

Surveys of secondary school students show that most of them are unaware of household chemicals. Therefore, it is natural to conduct experiments with substances used in life to develop the independent learning skills of learners. For example, when a small amount of baking soda and a diluted solution of acetic acid are mixed, the student will understand that a chemical reaction is taking place due to the formation of gas bubbles:



Students observe that a dilute sodium acetate solution remains after the reaction and that the resulting solution evaporates to form a supersaturated sodium acetate solution and

that the sodium acetate salt spontaneously crystallizes.

By showing the learner how to perform one such experiment, it is possible to conduct laboratory experiments that satisfy various topics.

For example, the exchange reaction of an acid and sour salt in the topic "Types of chemical reactions", the chemical properties of acids in the topic "Observation and properties of acids" and the topics "Reversible and irreversible reactions" are about gas separation and the formation of poorly dissociable substances. skills are strengthened.

The most important thing is that it is natural for students to understand that real chemical reactions are happening around us and that chemistry is closely connected with life.

There is no doubt that we will achieve the expected results if we introduce similar experiments in general education school classes, prepare educational and methodical manuals used for carrying out experiments, and deliver them to today's learners!

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