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INNOVATIVE SCIENCE TEACHING: PHOTOSYNTHESIS WITH BASF

Ayten Asgarova, Nurgun Aghayeva, Khammed Asadov and Khalil Naghiyev

Baku State University, Baku, Azerbaijan

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Chemistry, as a modern science, is aimed at forming generally accepted norms for the new generation. The main guidelines in this are: understanding the importance of life and its value orientations, the role of man in the world around him, the ability to find solutions to environmental, energy, food, and other global problems.

The development of new technologies, the integration of sciences, the achievements of genetics, biochemistry and biotechnology, bionics, have put human chemical education in one of the first places in the system of personal ideas and beliefs. The main purpose of the presented study is to study the impact of the use of the BASF virtual laboratory on the effectiveness of teaching "Photosynthesis" for law grade students.

From the conducted research, it can be concluded that the use of the BASF virtual laboratory, in accordance with the content and considering the age characteristics of students, significantly increases the level of knowledge not at the level of representation of events and processes, but at the level of formation of causal relationships. In addition, by providing visibility in the lessons, optimal conditions are created for the realization of learning goals, the formation of knowledge, abilities and skills that allow you to fully function in the future.

Keywords: science, chemistry, education, virtual laboratory, photosynthesis, teaching

INTRODUCTION

The most important component of the education system is a modern approach to the teaching methodology of science [1]. It is intended to form the basic dogmas of chemical education among the younger generations.

Chemistry is one of the most important and extensive fields of science, the science about substances, their composition and structure, their properties, dependence on composition and structure, their transformations leading to changes in composition — chemical reactions. This field has increased importance both in science in general and in school education [2].

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However, the study of chemistry is starting only in the 7th grade of the secondary school. In the present, there is a need to organize the learning process based on information and communication technologies, where electronic resources are used as information sources in a modern school. After all, only new information technologies will make it possible to realize the opportunities inherent most effectively in new pedagogical technologies. One of the problems of training is the insufficient equipment of classrooms. Now that information is

E-mail address:aytenasgarova@bsu.edu.az

becoming a resource for the development of society, modern education is undoubtedly an ongoing process.

The use of ICT in chemistry education allows students to develop the ability to navigate the information flows of the surrounding world, master practical ways of working with information, develop skills and form independence [3].

Due to the development of information technology, interactive platforms are being introduced into the educational process, and children can see experiments using dangerous substances such as mercury vapor, lead, yellow phosphorus. There are virtual programs that allow children to lead a demonstration experience and see the effects of mixing different reagents. For example, “BASF Kids’ Lab program was introduced since 2004 to help students explore the wonders of chemistry in daily life through safe and enjoyable experiments. Over the years, we have attracted more than 10,000 students through this innovative program [2].

The relevance of the study of the educational possibilities of virtual laboratories is related to the global process of digitalization of education, as well as the need to understand the experience of using virtual reality tools and technologies reality at various levels of education in order to identify the principles and conditions of their application [4].

The use of virtual laboratories allows you to replace outdated or expensive equipment, increase students' interest in the material being studied, to increase the accessibility and accessibility of learning through virtual modeling of natural processes, as well as to equip students to solve intellectual, creative and research tasks.

In the classical sense, a laboratory is understood as a department, that is, a physical place where scientific and technical experiments, experimental research, and analyses are carried out. In a figurative sense, a laboratory is called some kind of action, as a result or in the process of which elements of creativity arise, the search for a new experience or solution that has not yet been in the mind of the subject of this search. Thus, the classical definition emphasizes the possibility for the laboratory to be both a medium and a method of educational or scientific knowledge [3,4].

Conducting a lesson using an experiment in on-line mode does not provide a high degree of clarity of the material being studied but allows students to prepare for laboratory work or experiment on their own or under the guidance of a teacher. Virtual laboratories are the uptodate trend in natural science instruction supported by ICT and bring a new dimension not only to laboratories, but also to everyday life of students, teachers and every other person interested in science education. New possibilities to measure, to control anything from any computer, to receive current data from the opposite part of the world – these are and will bring immense motivation [4].

The preparatory process, in the lower grades, sets itself the task of training qualified personnel in the natural sciences. It is necessary to educate children to understand the importance of life as the highest value, to build their own relationship with nature based on mutual respect, based on evolutionary and ecological styles of thinking, as well as a chemical culture of behavior. In order to carry out fruitful work in the material or spiritual field, as well as to solve problems of environmental protection and maintaining a healthy lifestyle, it is necessary not only to provide students with relevant knowledge, but also to instill the skill of independent learning. Experimental work at the sites, independent observations, supported by work with methodological manuals, specialized literature and work on personal projects during the performance of assigned tasks, setting research experiments in the field of these sciences, will be especially fruitful. It is very important for a teacher to preserve and support students' interest in the subjects they study, which will help them decide on a profession in the future.

Photosynthesis is the most important process of nature world and is a regular part of the school science education. Photosynthesis and respiration play an essential role in the scientific understanding of interdisciplinary bonds [5,6].

Photosynthesis is usually studied three or four times at school. The first time it is mentioned in an elementary school. The result of this training is the widespread idea among grades 4-6 that plants breathe "not like animals and humans, but on the contrary: they inhale

carbon dioxide, and exhale oxygen". It is worth noting while the words "oxygen" and "carbon dioxide" are absolutely not clear to school children of this age, since they do not have any practical ways to detect these entities. They can only memorize and reproduce the phrase that "oxygen and carbon dioxide are gases that make up the air". That is why we believe that these terms should not be studied in elementary school.

Photosynthesis is studied for the second time in biology lessons in 5th and 6th grade, depending on the program used. The ideas being studied fit alongside already ingrained misconceptions, in most cases without transforming or changing them, and get along well with them in one head that is not sensitive to contradiction. Finally, for the third time, this "scientific knowledge" is complemented and enriched with a variety of chemical decorations and details (dark and light phases, etc.), and this happens in the 9th grade, and then in high school.

Having studied the state of the problem under study in the pedagogical literature [6-10], as well as having conducted an ascertaining observation at school, we moved on to experimental training. Our research was carried out in the younger age group, so we relied on the psychological characteristics of children of this age. The younger age is characterized by rapid uneven growth and development of the body, when intensive body growth occurs. Features in the physical development of the body often lead to arousal, irritability, which can be replaced by inhibition processes.

The main activity of the younger period is development. It is noted in the literature that "it was during this period that a new attitude towards a teaching in which the desire to acquire and find answers to questions, curiosity, the desire to predict, discuss, prove begins to come first [11-12].

Each of us must have a clear understanding of the world around him and the laws by which we develop. Without this knowledge, a person will not be able to feel like a useful member of modern society, assess the state of the surrounding nature, of which we are a part, and make the right decisions in everyday life.

Observations of the educational process at school have shown that verbal teaching of the discipline nature prevails among teachers .The choice of methods, in most cases, does not correspond to the content of the educational material.

As a result of the analysis of the literature data, it turned out that the problem of effective teaching of science in law grades is still stable and requires development.

The main purpose of the presented study is to study the impact of the use of the BASF virtual laboratory on the effectiveness of teaching "Photosynthesis" for law grade students.

EXPERIMENTAL

The object of the study is the educational process in “Science” in elementary school, including the study of the topic "Photosynthesis".

The hypothesis of the study is that the use of a virtual laboratory BASF, in accordance with the content and considering the age characteristics of students, will significantly increase the level of knowledge on the topic of "Photosynthesis". The purpose, object and subject of the study allowed us to put forward the objectives of the study:

1. To study the scientific, pedagogical, methodological literature on the problem of research.
2. To determine the state of the problem under study in the practice of school biological education.
3. To prove the correctness of the choice of methods of teaching science in accordance with the content when studying the topic "Photosynthesis".

The study included three stages.

1. *The ascertaining stage.* At this stage, the psychological and pedagogical literature was studied, the methodology of the experiment was determined, and the diagnosis of the initial level of development of students' knowledge for biology lessons was carried out.
2. *The formative stage.* At this stage of the study, a research experiment was being developed and tested.

3. *The control stage.* At this stage, the analysis, systematization, and generalization of the data obtained during the pedagogical research, the formulation of conclusions and the design of the final qualification work were carried out.

The experiment was conducted among students of two sixth grades of the lyceum "Young talents" of Baku State University. The topic "Photosynthesis" in the discipline "Nature" was chosen for the study. The discipline program is designed in a similar way to the subject "Science", which is taught in many public schools in leading countries of the world.

The control class studied the topic using modern teaching methods, but the teaching methodology did not include the use of a virtual laboratory, and in the experimental class, the BASF virtual laboratory was used as a teaching tool (https://virtualkidslab.basf.com).
The choice of this virtual laboratory is related to the following factors:

- intuitive design
- content suitable for the training program
- the possibility of conducting an independent experiment
- availability of the free version

The class was divided into 4 groups. Each group was given a laptop with an Internet connection. The leader of each group using the Google browser regulates actions in the laboratory by using the keyboard and mouse.

At each stage of action at BASF, the group members jointly put forward ideas, make decisions, discuss, justify, answer questions, and solve the problem step by step.

DISCUSSION AND CONCLUSIONS

The interface of this virtual laboratory is designed in such a way that allows a primary school student to independently conduct research. In the case if difficult situations arise, the student could use the help of a virtual assistant who instructs both using audio, video, and text format. at the same time, the interface is organized quite simply, and the student can intuitively navigate freely in the laboratory. When conducting independent research, the student is regularly asked problematic questions with possible answers, which stimulates him to active mental activity to find a way out of problematic situations. Transitions between the stages of the study are possible only after complete completion of the tasks of the stage, and a little testing. Thus, by the time the study is completed, the student already has a complete correct understanding of photosynthesis, the conditions of its course, the possibilities of its acceleration or deceleration (Fig. 1).

tosynthesis? – the student answers - Oxygen -, but at the same time he/she proves his/her point with a small test, bringing a virtual smoldering ray to the hole of a funnel filled with gas released by the plant.

Each step in the virtual laboratory is designed so that the student regularly encounters problematic situations and is forced to look for the right solutions himself, activating mental activity and including a creative component to move on to the next steps, rather than following a standard set of commands.

As can be seen from Fig. 1, the design of the BASF virtual laboratory is designed in very bright, colorful colors, which is also a motivating factor for the student's research activities, considering their age characteristics.

In the experimental class, lessons were conducted using innovative methods using the capabilities of the BASF virtual laboratory, which corresponded to the content of the educational material, considered the characteristics of each type of methods, the state of the material base and the age characteristics of the students.

As a result of observations, it turned out that because of working with BASF, trainees showed interest in the process, actively interacted with each other, which always has a positive effect on learning outcomes [13].

Fig. 1. The interface of the BASF virtual laboratory.

For example, when asked by a virtual assistant, what kind of gas is released during pho

After completing the training stages, a quiz was conducted among students of both groups to check the degree of assimilation of knowledge on photosynthesis and the degree of effectiveness of BASF application.

Quiz .

1. What is the photosynthesis?

_____

2. Which gas releases in photosynthesis?

_____

3. What powers the process of photosynthesis?

_____

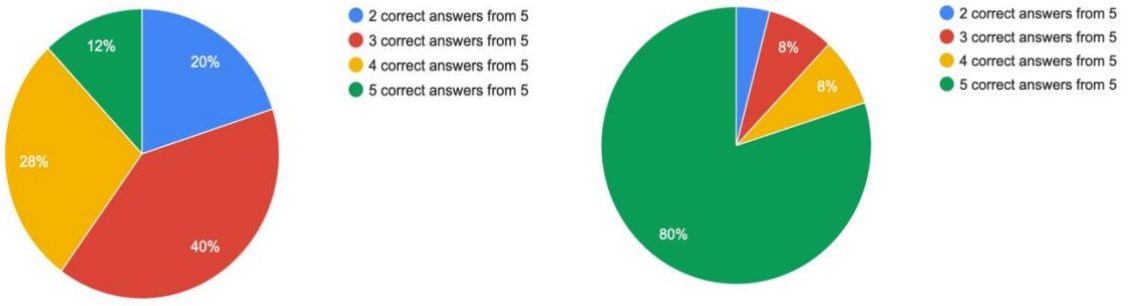
4. Where photosynthesis mainly takes place?

_____

5. Which of the following doesn't affect the rate of photosynthesis? (carbon dioxide, light intensity, oxygen concentration, temperature)

_____

The results of the experiment are shown in Fig. 2.



Control group Experimental group

Fig.2. The results of experiments in control and experimental group.

İt was established, that there are several objective reasons that make the use of virtual laboratories preferable. First of all, the conditions for distance learning, for which the organization of practical activities of students is very relevant and this fact satisfies with literature [14]. Another group of reasons is related to the inaccessibility of certain materials and tools for conducting educational experiments, the danger and harmfulness of the processes studied, the complexity of the equipment used, etc. As researchers note an increase in the activity of students, an increase in interest in academic subjects when using virtual laboratories [13-15].

The content of laboratory work corresponds to school program, The resource contains several multidirectional virtual experiments for chemistry. It can be used in the study of science in law grade classes.

BASF virtual laboratory can be used in classroom classes with a teacher or on their own, on the Internet or on a local computer, individually or in a group. In the virtual chemistry laboratory, it is possible to perform both individual experiments to demonstrate a specific property or phenomenon, and laboratory work on specific topics. The equipment of the chemical laboratory is visualized, the student can observe chemical reactions or independently conduct research by manipulating chemicals and laboratory instruments. Most often, the virtual laboratory is presented in the form of sections - tabs - theoretical material, description of work, procedure for performing work, laboratory installation, report. Some sites use animated characters and game elements.

The use of multimedia programs makes the study of chemistry more accessible and complete. BASF virtual laboratory allows for experiments that are not available in a real chemical laboratory. It is possible to accelerate chemical reactions, which allows you to spend less time on educational work, while not using expensive reagents. Sometimes it is necessary for students to know the rules of behavior in extreme situations, the peculiarities of the interaction of various chemicals (for example, sulfur with mercury). These rules can be learned in the safe environment of a virtual laboratory and prepared for real-world chemistry practice. In the virtual laboratory, the necessary skills of studying real processes are practiced, it is possible to prevent possible errors in the design and conduct of experiments, in the methods of handling reagents, with complex equipment. The use of a virtual laboratory in teaching chemistry both remotely and in regular classes allows you to increase the efficiency of homework, diversify it in form and content. Computer models of the chemistry laboratory encourage students to experiment and get satisfaction from their own discoveries. The predominance of one's own activity in the performance of practical work increases the cognitive interest of students. Virtual laboratories stimulate active interaction of students not only with the teacher, but also with each other, making them full-fledged subjects of educational and professional activity.

From the conducted research, it can be concluded that the use of the BASF virtual laboratory, in accordance with the content and considering the age characteristics of students, significantly increases the level of knowledge not at the level of representation of events and processes, but at the level of formation of causal relationships. In addition, by

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