EURASIAN JOURNAL OF ACADEMIC RESEARCH
Innovative Academy Research Support Center
UIF = 8.1 | SJIF = 5.685 www.in-academy.uz

USING THE CONCEPTS OF ANALYTICAL CHEMISTRY BASED ON THE INTEGRATION OF INFORMATION COMMUNICATION AND PEDAGOGICAL TECHNOLOGIES IN FORMATION OF NATURAL SCIENTIFIC LITERACY OF STUDENTS

[1]Shernazarov Iskandar Ergashovich
Tashkent State Pedagogical University named after Nizami
"Chemistry and its teaching methods" associate Professor, Ph.D
e-mail: shernazarov_iskandar855@mail.ru,
phone: +998998880281,
[2]Sapayeva Gulzor Islambayevna
Tashkent State Pedagogical University named after Nizami
"Chemistry and its teaching methods", teacher of the department
e-mail: yaqubovagulzor@gmail.com,
phone: +998908061201,
[3]Smanova Zulayho Asanaliyevna
National University of Uzbekistan
Head of the "Analytical Chemistry" department, doctor of chemical sciences, professor.
https://www.doi.org/10.37547/ejar-v03-i03-p1-10

ARTICLE INFO

Received: 24th February 2023
Accepted: 02nd March 2023
Online: 03rd March 2023

KEY WORDS

CSR, AKT, OECD, PISA, TIMSS, PIRLS, TALIS, WORD, EXCEL, POWERPOINT, ACCESS, PHOTOSHOP, CHEMDRAW, SCIFINDER, CROCODILE CHEMISTRY.

ABSTRACT

The main objective of the study is to increase the effectiveness of the use of analytical chemistry concepts based on the integration of information communication and pedagogical technologies in the formation of natural scientific literacy of students and to apply the developed methodological recommendations to practice. The methods of using information communication, pedagogical technologies and science integration in the formation of the students' natural scientific literacy were explained on the basis of tasks. In the course of the research, innovative technologies for teaching "Analytical Chemistry" were developed and based on the improvement of the application algorithm, the method of technologicalization of the presentation of educational information in the conditions of virtual laboratories in a demonstrative-figurative way, the scientific methodological content of preparing students for international evaluation studies based on the study and analysis of the results of international research in the continuous education system methodical structure and components of formation of creative activity, natural scientific literacy have been developed through clarification. Systematic evaluation programs in the

functional development of students' motivational skills and natural scientific literacy development of students' scientific practical competence based on an integrative approach, tools for developing creative activity and natural scientific literacy, results of monitoring the effectiveness of the methodology for developing natural scientific literacy of students based on international evaluation studies results were analyzed mathematically and statistically, and proposals and recommendations were developed in this regard. In the course of the research, concepts such as several information technology programs and working with them, correct interpretation of the integration of disciplines, completion of tasks, and scientific interpretation of tasks were mastered.

Introduction.

In the world, special attention is being paid to issues such as improving the field of chemical education, applying modern information and pedagogical technologies to the educational process, and developing methodological bases of teaching them in accordance with the modern development trends of natural sciences. The program developed by CSR Asia, one of the international organizations, recognizes the improvement of the quality of education on the basis of information and communication technologies (ICT) until 2030, which provides for the support and effective organization of the education of pupils and students. [1].

Globally, science and technology have become the main foundation of global development. Both entities continue to improve the quality of life as new discoveries are made based on science and technology.

Political, social and economic changes in the life of our republic also have an impact on the natural process of professional education, which is carried out in accordance with the society's demand for highly qualified, strong and deeply educated, self-motivated and capable personnel.

In the PISA, TIMSS, PIRLS, TALIS programs implemented by the Organization for Economic Co-operation and Development (OECD), the achievements of science and innovation are widely used in the education system today, and sustainable development of all spheres of society and state life, reflecting the comparative results of the education system is becoming an important factor in creating a worthy future of the country.

It is a fact that in developed foreign countries, it is recognized that education is a social process that actively influences the domestic policy of the country. Because of this, the amount of funds allocated for the economic provision of school needs in foreign countries is increasing year by year. It is important for quality changes and high efficiency in the field of education and its compatibility with global educational requirements, for students to achieve positive results by participating in international assessment programs in reading, mathematics, scientific literacy and creative thinking, to form the competences of students to

successfully use their knowledge in practice, to introduce an educational environment that creates conditions for the realization of their abilities, creativity, and initiatives.

Research objective. To increase the efficiency of using the concepts of analytical chemistry based on the integration of information communication and pedagogical technologies in the formation of natural scientific literacy of students and to implement the developed methodological recommendations in practice.

In our country, on the basis of advanced foreign experiences, reforms aimed at ensuring the development of modern competency-based approaches are being carried out in the general secondary education system, which provides for the formation of educational and cognitive competencies in students for the continuous education system. A number of activities are being carried out to modernize the content of modern education for the formation of learning-cognitive competencies in students, to create the necessary conditions that allow them to realize their inner potential.

Today, when our country has entered a new era of its development, investing in human capital and reforming education have become priority tasks.

According to decree of the President of the Republic of Uzbekistan No.PD-5538 dated by September 5, 2018 "On additional measures to improve the management system of public education" [2], decree No. PD-5712 dated by April 29, 2019 "On approval of the concept of development of the public education system of the Republic of Uzbekistan until 2030" [3], and the decree №PD-3931 dated by September 5, 2018 "On measures to introduce new principles of management into the public education system", achieving the inclusion of the Republic of Uzbekistan in the ranking of the PISA international program by 2030 among the first 30 advanced countries in the world, as well as in the public education system on the basis of the organization of international studies in the field of education quality assessment, the tasks of creating a national system of education quality assessment aimed at assessing the level of literacy of students in reading, mathematics and natural sciences are defined [4].

The level of study of the problem. Many scientists in the world, including Michael Seery, Stephanie O'Brien, Jesuraja Bosco Bharati, Hua-Jun Fan, Joshua Heads, Daniel Tran, and Nnenna Elechi, Savchenko L.A., Chernisheva L.A. and others have created a methodology for teaching chemistry using modern equipment in modern laboratory rooms based on information technologies and pedagogical technologies, and improving scientifically based teaching.

Issues of improving the quality of education in Russia, evaluating students' acquired knowledge of chemistry based on information and pedagogical technologies, the advantage of computer technologies in learning science, and the introduction of teaching students by combining effective methods of modern teaching were researched in the scientific and methodological works of such scientists as E. O. Emelyanova, E. Yu. Zashivalova, A. A. Syromyatnikov, V.N. Likhachev, A.A. Podgornova, A.S. Artemeva, O.E. Gorbunova, N.S. Mikhailova.

n Uzbekistan, many scientists, such as M.M. Aripov, A.A. Abdugadirov, A.Kh. Abdullaev, N.V. Apatova, U.Sh. Begimkulov, M. Lutfullaev, J.O. Tolipova, D. Yunusova have conducted scientific research on the use of computer technologies in the educational process,

E.U.Eshchanov, F.A.Alimova, L.T.Zaylobov, N.A.Anvarova conducted research works on teaching chemistry by introducing information and pedagogical technologies.

Development of tasks and organization of seminars on the state of preparation for the participation of the Republic of Uzbekistan in the International Assessment Research and the development of students' scientific literacy were handed over several experts such as A. Radjiev, A. A. Ismailov, H. J. Daminov, N. A. Karimov, G. O. Togaeva, K. K. Karimberdiev, Z. A. Kosimova, G. A. Pirimov, D. Askarova, S.R.Akbarova, M.Boymuratova. The training manual and seminar sessions created by them are reflected in the formation of students' literacy in international assessment research.

In order to improve the quality of education in the CIS countries and prepare for international evaluation systems, several scientists are conducting experiments and research. For example: G.S. Kovaleva, L.O. Roslova, G.A. Sidorova, A.Y. Pentin, N.A. Avdenko have conducted the assessment and development of creative thinking in the context of PISA international study; I.P. Nikitina, I.P. Ilin, N.Y. Khryasheva have conducted a research on the concept of teacher's creative activity, as well as possible ways of its formation and development; the main content of the formation of creative and creative abilities of students was researched by I. Sukhikh, E. Zeer, N. Khryasheva, O. Butorina.

Foreign scientists M. Hamilton, B. Maddox and K. Eddy, A.V. Wiseman, H.D. Meyer and A. Benavot, Barroso and de Carvalho, YE. Hanushek, W. Ludger, H. Rindermann and S.J. Ceci, Andreas Schleicher, in the context of the PISA international study of the Estado de São Paulo, carried out scientific research aimed at the assessment and development of creative thinking, the analysis of the results of international assessment studies of students, the development of reading, mathematical, natural science literacy.

Michael Seery justified the use of teaching technologies in chemistry classes considering the involvement of technology in education, discussing useful methods for improving technology in the field of chemistry [5].

Stephanie O'Brien offered insights on making more use of information technology in chemistry teaching and even creating a "paperless classroom." He explained that sometimes technology-based animations and applications can increase students' interest in chemistry, while traditional methods of teaching, if the textbooks are well written, the quality of the lessons can increase the students' level of knowledge [6].

The use of information technology and a good mastery of modern technology by Jesuraja Bosco Bharati is essential for teachers in explaining information about chemistry and performing laboratory procedures safely. Computer learning and teaching methods and the use of computers in the teaching process are described. It is necessary to talk about the use of computer software packages such as WORD, EXCEL, POWERPOINT, ACCESS, PHOTOSHOP, etc., as well as the use of special packages such as CHEMDRAW, SCIFINDER, and to prepare science-related tables, diagrams, animations, visual presentation processes based on their capabilities. The internet can be used to learn any technology. It is crucial to explain to students that the role of the Internet is much higher than classroom teaching, and they should also use more Internet information in classes. It has been explained in scientific research that students can have high-quality mental models if lessons are organized using ICT tools. [7; 11-16-p].

In "Teaching Chemistry with Computers" by Hua-Jun Fan, Joshua Heads, Daniel Tran, and Nnenna Elechilar, with the emergence of a new generation of technology and computer literate undergraduate students, advancements in science integration and software development in computer science have been suggested to reduce the reliance on books and written sources to learn chemistry. We present a variety of modules that you can use, not only to teach chemistry to illustrate complex concepts, but also to gain hands-on experience, allowing students to draw conclusions based on their own information. The new generation of undergraduate students is different, they want to learn quickly and in general they have less patience for reading books. Although we look at it and explain it to them, this new generation of students prefer internet information as the only way to absorb information. Even worse, some of these students never open their textbooks before exams and may not even open and read until the end of the semester. They search for answers and insights on Google, getting answers regardless of their accuracy and correctness. What drives some of us crazy is that some students simply copy and paste online answers and even advertise our services which we call plagiarism [8].

Savchenko L.A scientifically justified the use of information technology during teaching in Italian schools, the use of modern equipment in modern laboratory rooms, and the creation of a methodology for teaching students even during recess[9].

Chernysheva L.A developed the methods of using modern pedagogic and information technologies in the preparation of teachers of chemistry, practical training and gave the necessary recommendations [10; 25-p].

Alimova F.A. prepared animations, information and electronic educational manual on the topic of solutions and electrolytic dissociation [11; 97-99-p].

Shernazarov I.E. has created a monograph [**Ошибка! Источник ссылки не найден.**; 176-p] and an electronic training manual that serves to increase the educational potential of academic lyceum students on improving the teaching methodology of organic chemistry in the integration of information communication and pedagogical technologies [**Ошибка! Источник ссылки не найден.**].

The problems identified as a result of studying literature and scientific research include the following:

analytical chemistry has not been studied in the integration of information communication and pedagogical technologies;

lack of scientific research work to improve students' natural scientific literacy;

failure to use the integration of subjects in the formation of natural scientific literacy of students;

lack of use of information and communication technologies in the formation of natural scientific literacy among students:

the methods of scientific interpretation of natural phenomena are not studied in the formation of natural scientific literacy among students;

It was determined that the concepts of analytical chemistry related to natural phenomena have not been studied on the basis of information communication and pedagogical technologies, and the formation of natural scientific literacy of students based on our choice of this topic and sources related to the topic is one of the urgent problems.

Based on the identified problems, the purpose and tasks of the research:

Improvement of the technological method of demonstrative-figurative presentation of educational information in the conditions of virtual laboratories based on the development and improvement of the algorithm for the development and application of innovative technologies for teaching the science of "analytical chemistry" [12];

In order to improve the methodology of teaching "Analytical Chemistry", to develop an electronic study guide (which saves the student's time and increases the effectiveness of training) and a methodology for identifying analytical chemistry laboratory exercises with the help of ICT (animated, audiovisual presentations);

development of creative activity, methodical structure and components of formation of natural scientific literacy by clarifying the scientific-methodical content [13; 82-83-p] of preparing students for international evaluation studies based on the study and analysis of international research results in the continuous education system;

development of systematic assessment programs for the functional development of students' motivational skills and scientific-practical competence in the development of natural-scientific literacy of students based on an integrative approach to creative activity and natural-scientific literacy;

to determine the results of the monitoring of the effectiveness of the method of developing students' natural-scientific literacy based on international evaluation studies, from a scientific-pedagogical point of view, through experimental and test work, mathematical statistical analysis of the obtained results and development of proposals and recommendations in this regard;

development of methods of using analytical chemistry concepts based on information communication and pedagogical technologies in the formation of natural scientific literacy in students [14; 62-68-p].

Materials and methods. Taking into account the unique features of chemistry education in higher educational institutions in the field of natural sciences, the scientific-methodical bases of using the integration of information-communication and pedagogical technologies, the effectiveness and content of education, the coherence of teaching methods, tools and forms, and the pedagogical and information in teaching the science of "Analytical Chemistry". It is explained by the didactic possibilities of using technologies, the determination of criteria for evaluating the knowledge, skills, and abilities acquired by students, the development of electronic manuals and methodical recommendations aimed at improving the quality and efficiency of teaching "Analytical Chemistry" in natural higher education institutions [15; 1109-1114 -p].

Studying in students in the conditions of wide introduction of international assessment programs into the education system of our country, to develop methods for developing students' reading, mathematical and natural scientific literacy and creative activity, to justify the methodological conditions for the development of natural scientific literacy and creative activity of students in the process of teaching analytical chemistry, to develop the level of mathematical literacy of students the need to improve the ways of designing problematic assignments required conducting special scientific research in this direction.

Before realizing the goals given above, it is necessary to develop methods of teaching analytical chemistry to students based on information communication and pedagogical technologies.

As an example, let's focus on the possibility of the **Crocodile Chemistry** program from information technology programs.

The Crocodile Chemistry program allows you to study the chemical and physical properties of all the elements in Mendeleev's table. Usually, during chemical reactions, it is not possible to observe (at the molecular level) the process of transformation of the molecules participating in the reaction into another molecule [17; 44-52-p]. However, through this program, it will be possible to observe the dynamics of molecules during the reaction of a chemical substance with other substances. Through this program, you can model chemical processes, carry out various reactions, and most importantly, do it safely. This program can be widely used in teaching chemistry in higher educational institutions [18; 425-432-p].

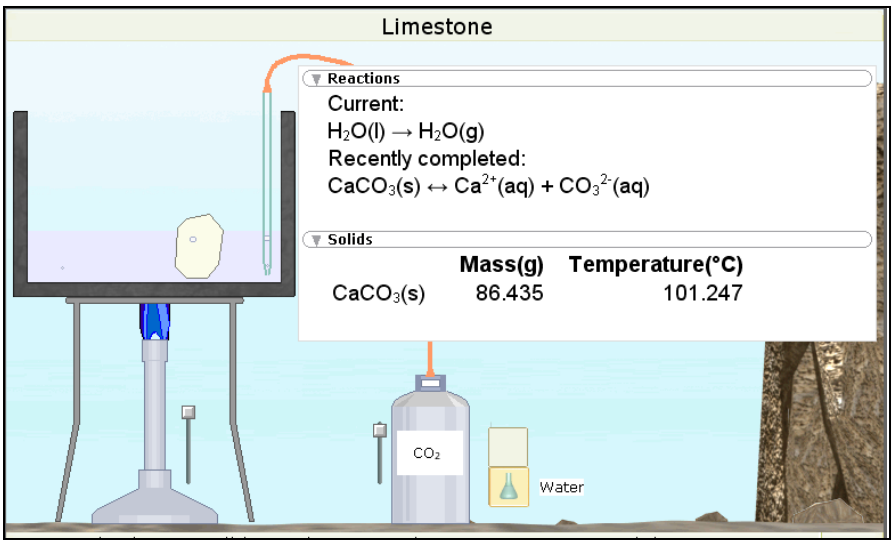


Figure 1. A chemical reaction process created in the Crocodile Chemistry software environment.

Through the program, using containers of arbitrary shape, it is possible to observe a chemical reaction by mixing different reagents. During a chemical reaction, the ability to see the color of reactants, the proportion of substances, chemical reaction formulas in a special window makes it possible to use the program as a powerful pedagogical tool. These features of the Crocodile Chemistry program have revolutionized the teaching of chemistry [16;453-460-p].

EURASIAN JOURNAL OF ACADEMIC RESEARCH
Innovative Academy Research Support Center
UIF = 8.1 | SJIF = 5.685 www.in-academy.uz

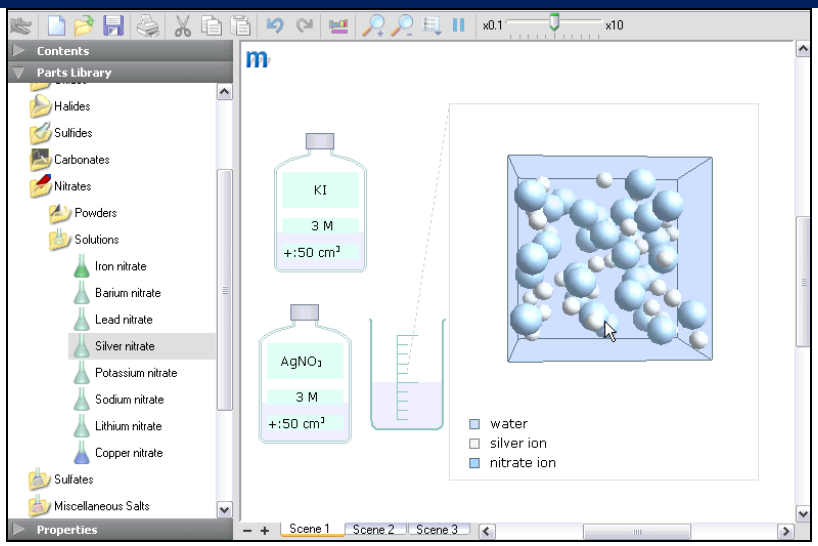


Figure 2. Movement of particles of substances in a chemical process created in the program environment of Crocodile Chemistry

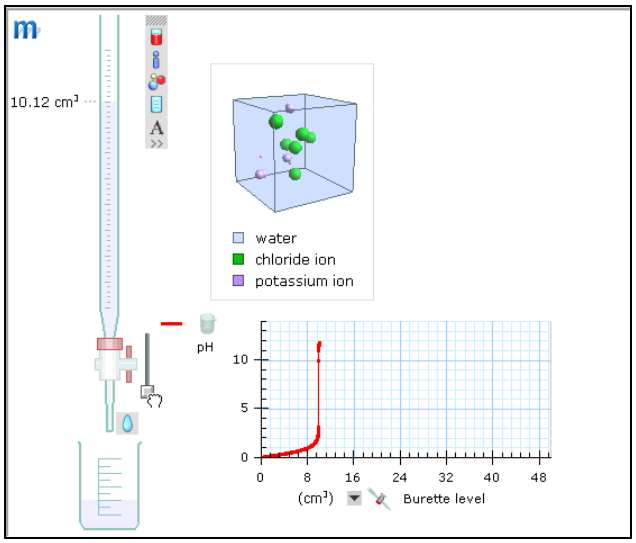


Figure 3. A graphical representation of volume change in a chemical process created in the Crocodile Chemistry software environment.

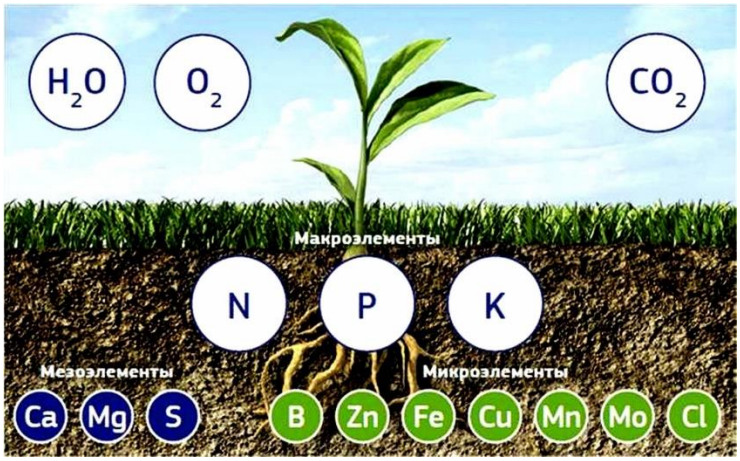
Based on such information communication and pedagogical technologies, a teaching methodology is developed and this methodology is used in each lesson.

How to use the concepts of analytical chemistry on the basis of information communication and pedagogical technologies in the formation of natural scientific literacy in students?

This question can be answered as follows.

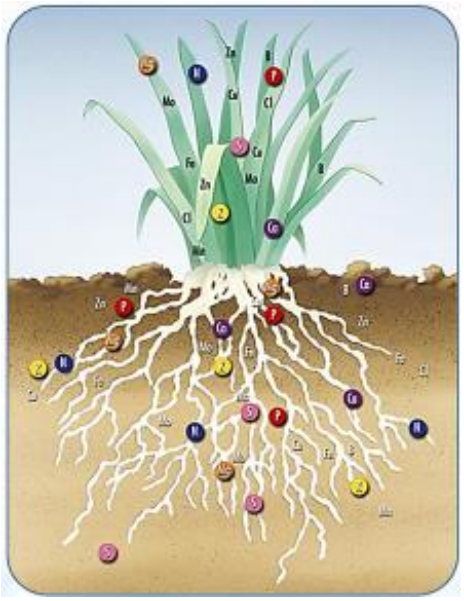
Concepts related to natural phenomena are made into color images or animations on the basis of information and communication technology programs. Pedagogical technologies are used to explain this process to students. For example: students should also learn the tasks of scientifically justifying the use of mineral fertilizers during the growth of one of the plants (tomato, corn or cucumber) for the project work [19; 1570-1577-p]. Students will have the skills to perform tasks based on international assessment studies and prepare contextual tasks related to them in the formation of the competence of scientific interpretation of data and evidence. It is necessary to scientifically analyze the results and conclusions obtained

during the performance of the tasks given in the project works. Let's represent the same process in an animated way and use the animation representing the mineral fertilizers given as feed to grow the corn varieties given to the students as a project work. Scientifically justify when the mineral fertilizers shown in the animation are given to the corn variety and how important it is for their growth. It will take at least 3 to 6 months to complete the project work. During this time, it is necessary to determine which mineral fertilizers are given and how they affect the corn variety. We can quickly explain this process to students thro ugh an animated view [20; 1578-1586-p].



As can be seen from the above animated process, students should be familiar with inorganic, analytical and agrochemical sciences in order to complete this task. Analytical chemistry is used to determine the effects of cations and anions contained in fertilizers given to plants as nutrients, and inorganic chemistry can be used to determine what minerals are needed by plants. Through the science of agrochemistry, it is determined when mineral fertilizers should be given [21; 471-477-p]. Pedagogical technologies are used to explain this information to students. So, at the same time, it is possible to form natural scientific literacy in students by using the concepts of chemistry (*asynchronous* subjects of the same direction) on the basis of information communication and pedagogical technologies. We can also give a similar assignment:

Task 1: along with local fertilizers, the importance of mineral fertilizers is very high in obtaining high yields from agricultural crops. Elements such as carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, iron are necessary for plants to live normally. Nitrogen, phosphorus and potassium are especially important among these elements.



The chemical composition of plants includes inorganic substances (water and salts), organic substances (proteins, fats, carbohydrates and nucleic acids).

Inorganic substances		Organic substances			
Water	Salt	Proteins	Fats	Carbohydrates	Nucleic acids
H, O	P, N, K, Ca, Mg, Fe, Mn, Zn, Cu……	C, H, O, N, P, S	C, H, O	C, H, O	C, H, O, N,

About 70 of these elements are found in plants. Elements in plants are divided into macroelements (C, H, O, N, P, S, Mg, K, Ca), microelements (Fe, Mn, B, Cu, Zn, Mo, Co). These elements have different effects on plants. For example: potassium affects the bud, flower and fruit of the plant. Nitrogen is necessary for the growth of stems and leaves. Phosphorus is necessary for the growth of roots.

If there is a lack of nitrogen in the plant, the leaves will crumble, the growth of the plant will slow down, the lower part of the leaves will turn yellow, and the plant will yield less. If the amount of nitrogen increases - the growth of the plant accelerates, the leaves become larger, the lower leaves begin to curl, the crop does not ripen [27; 514-522-p].

If the amount of phosphorus is insufficient, the growth of the plant slows down, the leaves become bluish-green, spots appear on the lower part of the leaves, the leaves bend and fall yellow. If the amount of phosphorus increases, the tips and edges of the leaves will burn (yellowish-brown), new leaves will grow thin, the lower leaves will bend and a spot will form, and the yield will decrease.

Some elements iron accelerates the assimilation of nitrogen, phosphorus and potassium in the form of macro and microelement ions in the plant.

Copper, zinc and manganese accelerate the oxidation-reduction process that occurs in plants. As a result of the analytical analysis of the given processes, it is necessary to scientifically justify the effect of the potassium element on plants [26; 147-149-p].

Depending on the presence of nutrients in mineral fertilizers (N, K_2O, P_2O_5) they can be divided into simple or complex fertilizers.

Task 2: In order to obtain a high yield from agricultural plants, it is necessary to use meniral fertilizers correctly. For example: explain in analytical chemistry which fertilizers should be used to ripen tomato and watermelon plants and how they are absorbed by the plants in the form of ions and their effects.

Task 3: most modern cars have a catalytic converter installed, which reduces the harm to people and the environment from the exhaust gases coming out of the car. About 90% of harmful gases are converted into less harmful gases. The diagram shows some of the gases entering and leaving the converter.

EURASIAN JOURNAL OF ACADEMIC RESEARCH
Innovative Academy Research Support Center
UIF = 8.1 | SJIF = 5.685 www.in-academy.uz

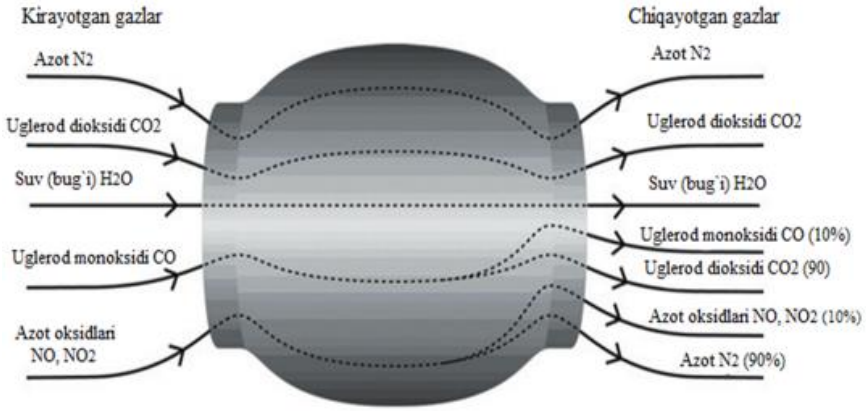


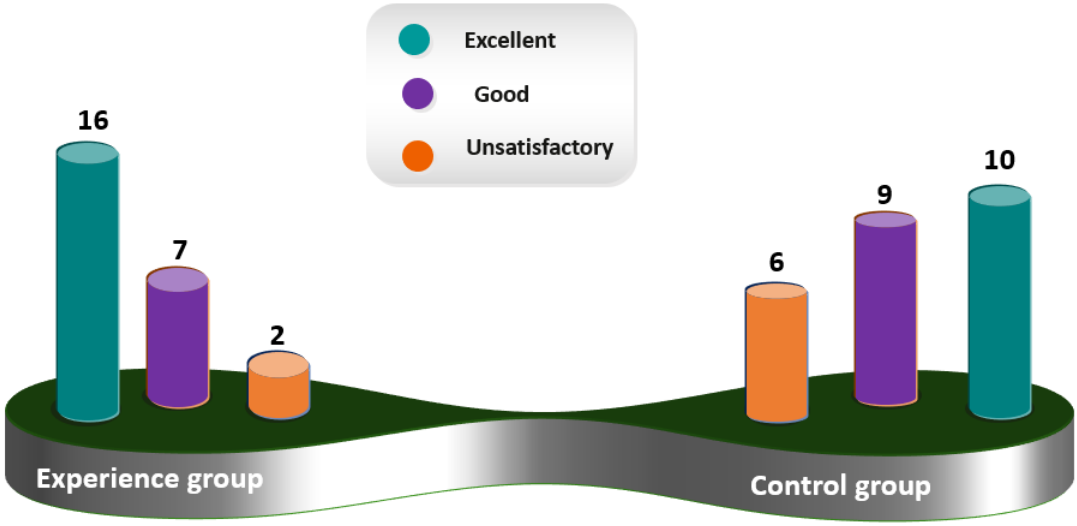
Figure 3. Catalytic converter

Using the information in Figure 3 above, explain using analytical chemistry how to reduce the harm of catalytic converter exhaust gases and convert them into useful products (useful solution).

By teaching students to perform the tasks given above and analyze their results, students can form their natural scientific literacy through analytical concepts based on information communication and pedagogical technologies [22; 9-22-p].

Results: similar to the above tasks and using international evaluation research tasks, it worked very well when we tried to explain analytical concepts based on the integration of information communication and pedagogical technologies to students of higher education institutions. Two 3-year students were selected from the students of the higher education institution (25 in each group, 50 in total). The students of the first group are the experimental group, and the students of the second group are the control group. Lessons were organized in the experimental group by analyzing the concepts of analytical chemistry based on information communication and pedagogical technologies. In control group B, lessons were organized in traditional methods (lecture, brainstorming). In order to analyze the acquired knowledge, both groups were given the same tasks and their results were analyzed. According to the obtained results, the following was achieved.

Group	Number of students	Excellent mark	Good mark	Satisfactory mark	Unatisfactory mark	Quality indicator
Experimental group	25	16	7	2	0	92%
Control group	25	10	9	6	0	76%
The difference in results		6	-2	-4	0	16%



As a result expressed in the above table, it was determined that the natural scientific literacy of the students in the experimental group was 16% higher than the natural scientific literacy of the students in the control group.

Discussion.

The purpose of the study was to increase the efficiency of using the concepts of analytical chemistry based on the integration of information communication and pedagogical technologies in the formation of natural scientific literacy of students and to implement the developed methodological recommendations [23; 73-77-p].

During the research, the methods of using information communication, pedagogical technologies and science integration in the formation of students' natural scientific literacy were explained on the basis of assignments.

The task of the research is fulfilled. For example:

Innovative technologies for teaching "Analytical Chemistry" have been developed, and based on the improvement of the application algorithm, the method of technology transfer of educational data in the conditions of virtual laboratories has been improved;

In order to improve the teaching methodology of “Analytical Chemistry”, an electronic study guide (which saves the student's time and increases the effectiveness of the training) and a method of identifying analytical chemistry laboratory exercises with the help of ICT (animation, audio-visual images) have been developed [24];

The methodical structure and components of creative activity and natural scientific literacy have been developed by clarifying the scientific-methodical content of preparing students for international evaluation studies based on the study and analysis of international research results in the continuous education system.;

systematic evaluation programs for the functional development of students' motivational skills for educational and learning activities and tools for developing their creative activity and natural scientific literacy have been developed based on an integrative approach to scientific-practical competence in the development of natural-scientific literacy of students;

on the basis of international assessment studies, the results of monitoring the effectiveness of the method of developing students' natural-scientific literacy were

determined from the scientific-pedagogical point of view through experiments and tests, the results were mathematically and statistically analyzed, and proposals and recommendations were developed in this regard;

the method of using the concepts of analytical chemistry based on information communication and pedagogical technologies in the formation of natural scientific literacy among students has been developed [25; 1-5].

In the course of the research, concepts such as a number of information technology programs and working with them, the correct interpretation of the integration of sciences, the completion of tasks, the scientific interpretation of tasks were mastered, so we achieved the goal set before us, and we were able to complete the tasks.

It was relatively more difficult for students to develop the skills of working with assignments while doing research.

Recommendations based on research results:

the use of science integration in the formation of natural scientific literacy in students;

use of integration of information communication and pedagogical technologies;

it was emphasized that it is necessary to teach the scientific interpretation of natural phenomena through the concepts of chemistry.

References:

1. The role of ICT in realizing education for all by 2030 Achieving Sustainable Development Goal 4. – p. 1-46. http://www.csr-asia.com/download/ICT4SDG4-Final-Version.pdf.
2. Ўзбекистон Республикаси Президентининг 2018 йил 5 сентябрдаги “Халқ таълимини бошқариш тизимини такомиллаштириш бўйича қўшимча чора-тадбирлар тўғрисида”ги ПФ-5538-сон фармони
3. Ўзбекистон Республикаси Президентининг 2019 йил 29 апрелдаги ПФ-5712-сон “Ўзбекистон Республикаси халқ таълими тизимини 2030 йилгача ривожлантириш концепциясини тасдиқлаш тўғрисида” фармони.
4. Ўзбекистон Республикаси Президентининг 2018-йил 5 сентябрдаги ПҚ-3931-сон “Халқ таълими тизимига бошқарувнинг янги тамойилларини жорий этиш чора-тадбирлари тўғрисида” қарори
5. Michael Seery. Technology enhanced learning in the chemistry classroom.: Paper Presented to International Conference on Initiatives in Chemistry Teacher Training, Limerick IT, November 2013.
6. Stephanie O‘Brien “Technology Cjnsiderations for the Chemistry Classroom” https://www.chemedx.org/article/technology-considerations-chemistry-classroom
7. Jesuraja Bosko Bharati “Kimyoni o‘qitish va o‘qitishning kompyuter usullarining ahamiyati”. Ta'lim haqidagi ilmiy jurnal. Maxsus son: oliy ta’lim tizimida tabiiy fanlarni o‘rganish. 3-jild, № 4-1, 2015, 11-16 betlar. doi: 10.11648/j.sjedu.s.2015030401.13
8. Hua-Jun Fan, Joshua Heads, Daniel Tran, and Nnenna Elechi. Kompyuterlar yordamida kimyo fanidan dars berish. International Journal of Information and Education Technology, Vol. 5, No. 3, March 2015
9. Savchenko L.A. “Innovative path of teaching/learning during the active formative training (TFA) in an italian higher secondary school”. Checchetti Andrea Istituto d’Istruzione Superiore

"Leonardo da Vinci" San Giovanni in Fiore (Cs). – ITALY: European journal of Research and Reflection in Educational Sciences. No.1, 2015.
10. Chernisheva L.A. Metodika podgotovki budushix uchiteley ximii posredstvom resheniya situatsionno-metodicheskix zadach v usloviyax pedagogicheskoy praktiki.:Avtoreferat dis.kand.ped.nauk.-Bryansk:-2017.-25 s
11. Alimova F. A. Project activities of students in the digital educational environment //Asian Journal of Research in Social Sciences and Humanities. – 2021. – T. 11. – №. 12. – C. 97-99.
12. Alimova F. A. ORGANIZATION OF INDEPENDENT WORK OF FUTURE TEACHERS OF CHEMISTRY ON THE BASIS OF PROJECT ACTIVITIES //Web of Scientist: International Scientific Research Journal. – 2022. – T. 3. – №. 02. – C. 552-557.
13. Berdiqulov R. S. KIMYO TA'LIMIGA MANTIQ QOIDALARINI INTEGRATSIYALASH TO 'G 'RISIDA //Talqin va tadqiqotlar ilmiy-uslubiy jurnali. – 2022. – №. 1. – C. 82-85.
14. Berdikulov R. S. DEDUCTION OF CHEMICAL THOUGHT //European Research. – 2017. – №. 5. – C. 62-68.
15. Berdiqulov R. DEDUCTIVE ANALYSIS TEACHING CHEMISTRY LOGICAL QUALITATIVE FOUNDATION //Science and Innovation. – 2022. – T. 1. – №. 8. – C. 1109-1114.
16. Shernazarov I. E., Abdukadirov A. A. Information technology usage methods in expressing components in organic chemistry course //Asian Journal of Multidimensional Research (AJMR). – 2018. – T. 7. – №. 9. – C. 453-460.
17. Shernazarov I. E. " Organic chemistry" laboratory of information technologies in teaching process //TRANS Asian Journal of Marketing & Management Research (TAJMMR). – 2018. – T. 7. – №. 11. – C. 44-52.
18. Shernazarov, I. E., & Abdukadirov, A. A. (2018). Methodology of information technology information of ifodalization of components in organic chemistry course. Asian Journal of Multidimensional Research (AJMR), 7(9), 425-432.
19. Bektosheva S. et al. IMPROVING THE METHODOLOGY OF DEVELOPING FUNCTIONAL LITERACY IN STUDENTS //Science and Innovation. – 2022. – T. 1. – №. 8. – C. 1570-1577.
20. Shernazarov, I., & Xodjabayeva, N. (2022). THE IMPORTANCE OF MODERN TECHNOLOGIES IN THE USE OF MATERIALS FROM INTERNATIONAL EVALUATION STUDIES. Science and Innovation, 1(8), 1578-1582.
21. Ergashovich, S. I. (2022). THE USE OF INTERNATIONAL ASSESSMENT RESEARCH COMPETENCIES IN THE FORMATION OF THE LITERACY OF FUTURE CHEMISTRY TEACHERS. Web of Scientist: International Scientific Research Journal, 3(12), 471-477.
22. Ergashovich, S. I. (2021). USE OF INTEGRATED TECHNOLOGIES IN PREPARING HIGHER EDUCATIONAL INSTITUTION STUDENTS FOR INTERNATIONAL ASSESSMENT PROGRAMS ON" ORGANIC CHEMISTRY". Emergent: Journal of Educational Discoveries and Lifelong Learning (EJEDL), 2(01), 9-22.
23. Iskandarov, A. Y. (2022). TO COMBINATE THE CHEMICAL TASKS ON THE BASIS OF SYSTEMATIC ANALYSIS. European International Journal of Multidisciplinary Research and Management Studies, 2(04), 73-77.
24. Iskandarov, A. Y., & Makkamov, N. (2021). CHEMICAL PROBLEM SOLVING AS A METHOD OF INCREASING STUDENTS'COGNITIVE ACTIVITIES.

25. Iskandarov, A. Y., Shomurotova, S. X., & Kamolova, N. (2020). Forming a methodology for developing students' creativity using creative methods in teaching chemistry to future chemistry teachers. INTERNATIONAL JOURNAL OF DISCOURSE ON INNOVATION, INTEGRATION AND EDUCATION, 1(2), 1-5.
26. Ismailov S. A., qizi Avazova K. E., Dangalova A. A. THEORETICAL BASIS OF USING INTERACTIVE MEDIA RESOURCES IN TEACHING CHEMISTRY //INNOVATIVE DEVELOPMENT IN THE GLOBAL SCIENCE. – 2022. – T. 1. – №. 6. – C. 147-149.
27. Ismailov S. A. KIMYO FANINI O'QITISHDA HAMKORLIKDA O'QITISH TEXNOLOGIYASI VA KICHIK GURUHLARDA ISHLASH, SPINNER METODIDAN FOYDALANISHNING AHAMIYATI //Academic research in educational sciences. – 2021. – T. 2. – №. 1. – C. 514-522.