FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION
OF HIGHER PROFESSIONAL LEARNING
KAZAN (VOLGA REGION) FEDERAL UNIVERSITY

As a manuscript

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# FORMING A CHEMICAL-ECOLOGICAL CULTURE OF STUDENTS THROUGH INFORMATION TECHNOLOGIES IN PROJECT ACTIVITIES

**13.00.01 – General Pedagogy, History of Pedagogy and Education**

**SYNOPSIS**

**Ph.D. thesis for Candidate of Education**

**Kazan – 2020**

The thesis is completed at the Department of Chemical Education of Chemical Institute named after A.M. Butlerov of Federal State Autonomous Institution of Higher Professional Learning “Kazan (Volga Region) Federal University”, the Ministry of Science and Higher education of the Russian Federation.

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The thesis protection will take place on December 23, 2020, at 12.30 p.m. at the meeting of the Dissertation Council KFU.13.01 at the premises of FSAEI of HE Kazan (Volga) Federal University at auditorium 322, №1, Mezhlauk Street, Kazan, 420021.

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The synopsis is sent out on November 11, 2020.

Academic Secretary
of the Dissertation Council of KFU.13.01
Doctor of Education, Professor V.G. Zakirova

## GENERAL DESCRIPTION OF THE THESIS

**The relevance of the research.** One of the principal issues of modern education remains that of forming an ecological culture of students in comprehensive institutions. According to the priorities outlined in the document “Bases of State Policy” in terms of environmental development of the Russian Federation for the period up to 2030 (approved by President of the RF on April 30, 2012), forming an environmental culture, the development of ecological education and upbringing are considered a strategic goal of the state policy in terms of the environmental development.

According to the Federal State Educational Standard (FSES) of the basic general education of the new generation, ecological education is realized as an ecological component of basic subjects as well as a varied lesson component and part of extra-curricular activities. It is stated that in the process of natural scientific (chemical-biological) education students are “brought up to carefully and responsibly treat the environment, apply the eco-systemic educational model to foresee ecological risks for people’s health, the safety of their lives, quality of the environment, awareness of the importance of the concept of the stable development”; they get notions of the importance of natural scientific knowledge “solving the problems of rational nature management, protecting people’s health in conditions of quick changing of the ecological quality of the environment”.

At the same time it is known that a chemical component is considered crucial in the global anthropogenic negative influence on the environment. However, the overwhelming majority of methods of monitoring the pollution and purification of the objects of the environment are also chemical. It stresses the importance of a chemical aspect of ecological research and actualizes forming a chemical-ecological culture as a necessary component of an ecological culture of a personality. Students may acquire it provided that ecologically-oriented project activities are applied while teaching chemical-biological subjects both in class and in extra-curricular activities.

Forming an ecological (specifically chemical-ecological) culture is connected with the concept of B.T. Likhachev and his system of continuous ecological education, as well as with a personality’s ecology. The necessity of its formation among young students in the aspect of the humanization of education is disclosed in the works of A.A. Verbitskiy, I.T. Gaisin, A.N. Zakhlebnyy, I.D. Zverev, N.M. Mamedov, V.A. Mironov, L.V. Moiseeva, G.V. Mukhametzyanova, Z.G. Nigmatov, N.K. Sergeev, I.T. Suravegina and other scientists. According to S.D. Deryabo and V.A. Yasvin, the formation of a personality with an ecocentric type of mind is considered the main purpose of ecological education. Various aspects of the formation of ecological knowledge while learning natural scientific subjects are examined in the studies of T.O. Volkova, N.F. Vinokurova, S.I. Gilmanshina, R.Y. Dyganova, A.R. Kamaleeva, V.N. Mikhelkevich, V.V. Serikov, R.M. Yakupov and others.

At the same time, little consideration has been given to the problem of forming a chemical-ecological culture and its role in the ecological safety of the society. The potential of information technologies and the significance of the new information and

educational environment in the realization of the process, including the project education, has not been investigated either.

In the Federal State Educational Standards of the new generation (the methodological basis of the formation of the content is a systems approach) apart from the contents of education and requirements to its results there are requirements for the educational environment. It is connected with the fact that a traditional educational environment cannot fully provide achieving of modern educational results, indicated in the standards. There is an issue about forming a new educational environment based on modern educational technologies – information-communication technologies and project activities, the application of which is perspective for the realization and development of educational needs and cognitive abilities of students.

Modern natural scientific education is inconceivable without an active application of information technologies. Information competence is one of the goals of the general education. It assumes a complex ability to self-independently find the necessary information, analyze, represent and share it, as well as model, design objects and processes, realize projects.

Consequently, forming a chemical-ecological culture through information technologies as a result of a systematic implementation of cross-curricular connections of informatics with the subjects of natural scientific group is becoming a vital problem of the modern didactics, though the issues of the informatization of education have always attracted researchers' attention. However, the researchers' works do not provide solving of a pedagogical multicomponent problem of forming a chemical-ecological culture of students through information technologies in project activities. As a result, in science there is no full analysis of the features of forming a chemical-ecological culture of students through information technologies in project activities. Besides, pedagogical notions about objectives, ways, forms, stages, conditions, methods, and modes of the organization of such work are not given in detail.

There are **contradictions** between:

a) needs of the government and the society in graduates of comprehensive institutions possessing a chemical-ecological culture in the modern conditions of the increased chemical impact on the environment and an insufficient theoretical and practical development of a pedagogical model of its forming in students in the project extra-curricular activities in accordance with the FSES;

b) the necessity of creating pedagogical conditions of forming a chemical-ecological culture of a personality in the new educational environment based on modern information technologies and insufficient development of theoretical and practical bases of the process in question when teaching chemical-biological subjects in comprehensive institutions.

These contradictions point out the relevance of the chosen area of research and allow stating the **problem of the research**: what is the scientific and methodological support of forming a chemical-ecological culture of students through information technologies in project activities.

The suggested research may be considered as one of the attempts of searching the ways of solving the stated problem taking into account the new information educational environment.

**The research topic** is forming a chemical-environmental culture of students through information technologies in project activities.

**The purpose of the research** is to elicit, substantiate theoretically and verify experimentally the efficiency of the organizational and pedagogical model of forming a chemical-environmental culture of students through information technologies in project activities.

**The research object** is the process of forming a chemical-ecological culture of students in project activities.

**The research subject** presents pedagogical conditions and a model of forming a chemical-ecological culture of students through information technologies in project activities of chemical-biological education.

**The research hypothesizes** that forming a chemical-ecological culture of students through information technologies in project activities will be successful, if:

- *at the functional target level* will be revealed the contents and the structure of a chemical-ecological culture of students;
- *at the substantial level* will be fulfilled the selection and the structuration of the contents of the preparation in natural scientific subjects following the pedagogical possibilities of information technologies in the system of forming a chemical-ecological culture of students;
- *at the theoretical level* will be given proof and realized pedagogical conditions of forming a chemical-ecological culture of students through information technologies in project activities:
- *at the technological level* will be stressed the integration of information technologies with traditional ones while teaching chemistry, biology, ecology in project activities;
- *at the methodological level* the process in question will be built based on a pedagogical model, the structural components of which will ensure the effective forming of a chemical-ecological culture of students using information technologies in project activities;
- *at the monitoring and evaluation level* will be worked out the criteria and carried out the experimental verification of the efficiency of the pedagogical conditions and the model of forming a chemical-ecological culture of students utilizing information technologies in project activities of the chemical-biological education.

**The objectives of the research**, which have called forth the logic of the description of the scientific material, are the following:

1. To define the contents and the structure of a chemical-ecological culture, the purpose, the objectives, and the functions of its forming in conditions of the new information educational environment of the school ecological education.
2. To elicit pedagogical conditions of forming a chemical-ecological culture of students through information technologies and substantiate the necessity of

the integration of the latter with the traditional technologies of teaching chemistry, biology, ecology in project activities.

3. To work out the pedagogical model of forming a chemical-ecological culture of students through information technologies in project activities realizing the elicited pedagogical conditions.

4. To work out the criteria, their indices and experimentally verify the efficiency of the pedagogical conditions and the model of forming a chemical-ecological culture of students through information technologies in project activities when teaching chemistry, biology, ecology.

**The theoretical and methodological basis of the research** is:

- the concept of continuity and succession of chemical education and upbringing (S.V. Alekseev, S.D. Deryabo, A.N. Zakhlebnyy, I.D. Zverev, I.T. Gaisin, B.T. Likhachev, L.V. Moiseeva, N.F. Reimers, I.T. Suravegina, V.A. Yasvin), of ecological culture and ecological-humanistic world-view (B.T. Likhachev, G.V. Mukhametzyanova, Z.G. Nigmatov, E.V. Muravyeva, A.N. Khuziakhmetov); ideas of cognition and transformation of a person in their activity (L.S. Vygotskiy, A.N. Leontyev, S.L.Rubinshtein, D.I. Fildshtein);
- ideas of a health saving information educational environment of an educational institution (I.Sh. Mukhametzyanov, I.V. Robert, F.Sh. Mukhametzyanova), of an information environmental approach; propositions of creating and using educational tools in the information educational environment (G.V. Ivshina, I.V. Robert, O.A. Ilchenko, E.S. Polat);
- concepts of student-centered teaching (S.N. Mitin, E.S. Polat, I.S. Yakimanskaya), of a systems approach to teaching and upbringing (Y.K. Babanskiy, V.P. Bespalko, V.I. Zagvyazinskiy, V.K. Kirillov, V.V. Kraevskiy), of integrated teaching and cross-curricular connections (G.I. Ibragimov, I.Y. Kuramshin, M.S. Pak, S.I. Gilmanshina), of the greening of natural scientific education (I.T. Gaisin, S.I. Gilmanshina, R.Y.Dyganova, V.N. Mikhelkevich, V.V. Serikov, etc.);
- theoretical as well as psychological and pedagogical principles of project education (P.F. Kapterev, P.P. Blonskiy, S.T. Shatskiy, E.G. Kaganov, V.V. Ignatyev, M.V. Krupenina, I.D. Chechel, V.D. Simonenko, M.V. Retivykh, N.V. Matyash, M.B. Pavlova, etc.).

**Research methods.** The whole set of research methods were used based on a dialectic combination of theoretical and practical approaches. Among theoretical methods, we can mention theoretical analysis and synthesis, abstraction and concretization, analogy and modeling. General empirical methods include a pedagogical experiment, experimental search work, learning and generalization of the pedagogical experience, as well as learning of scientific literature, documents, and results of the activity, observation, questioning, testing, conversations, comparing and generalization of the experience of teachers of comprehensive schools and gymnasiums, analysis of educational programs and toolkits.

Experimental data processing methods are mathematical and statistical processing of the results received in the course of the investigation, diagnostic and

framing experiments, techniques for analyzing pedagogical situations, students' self-report.

**The research framework of the experiment.** The main research work was carried out in 7-11 grades of the secondary comprehensive institutions (MBEI "Gymnasium №122 named after Zh.A. Zaitseva" of Moskovskiy District of Kazan city, MBEI "Gymnasium №4" of Kirovskiy District of Kazan city) from 2011 till 2018. (Altogether, 320 students and 70 teachers participated, including the questionnaire.)

*Stage one* (2011-2014). In the course of the pedagogical observation search on the premises of the secondary comprehensive institutions of Kazan city, various empirical materials were being accumulated. The problem, the purpose, the object, the subject, the hypothesis, and the objectives of the research were defined. The theoretical research framework was being worked out.

Modern requirements to the chemical-ecological culture of students were being studied. Pedagogical conditions were being elicited; tasks of modeling the process of forming a chemical-ecological culture of students through information technologies in project activities were being solved.

*Stage two* (2014-2016). The organization and implementation of the forming pedagogical experiment to verify and clarify the research hypothesis were carried out.

*Stage three* (2016-2018). The testing phase of the experiment was carried out. Systematization, generalization, presentation, and discussion of the results at scientific conferences, development of relevant methodological recommendations, their implementation into practice, structuration and discussion of the thesis were fulfilled.

*Stage four* (2018-2019). The accumulated scientific facts, the main results of the research were summarized and designed as articles and the thesis.

**The scientific novelty of the research** is that:

1. The content and the structure of the chemical-ecological culture of a personality have been elicited. In its correlation, it reflects a chemical and environmental-law competence concerning the regulation of the activity of people, ensuring the necessary quality of the natural environment in conditions of a post-industrial, information society.
2. A pedagogical model of forming a chemical-ecological culture of students through information technologies in project activities representing a set of seven interconnected blocks, such as functional-targeted, theoretical and methodological, organizational, substantial, technological, methodological, monitoring and evaluation ones, has been worked out. Its successive realization permits to purposefully form a chemical-ecological culture of a personality, using at most the pedagogical potential of information technologies in project activities.
3. A complex of pedagogical conditions of efficient forming a chemical-ecological culture of students through information technologies in project activities has been elicited and substantiated. This is an implementation of extra-curricular courses based on multimedia and distant technologies, internet-technologies, electronic educational resources, aimed at forming a chemical-ecological culture and

encouraging self-independent work with regard for the specificity of the region and the integrity of natural ecosystems; optimal update of the content of the preparation on chemical-biological subjects in accordance with the opportunities of information technologies in project teaching to form the systemic knowledge regarding ecologically safe actions: taking into account age and individual characteristics of students, their interest to information technologies, when working out academic and research projects promoting health-saving and energy conservation, to preventing natural and man-made disasters regarding a chemical component; strengthening of a reflexive character of ecologically safe actions in the natural and virtual environments.

4. The pedagogical potential of information technologies while forming a chemical-ecological culture of students has been elicited. It assumes the extension of the self-independent work contributing to conscious learning of ecologically safe activity regarding the specificity of the region and integrity of natural ecosystems; interactive ecologically oriented teaching with the use of dynamic images of the studied objects; visual scientific forecasting of the distant consequences of ecological problems whose solving requires action skills in critical conditions as well as extensive chemical knowledge; integration of information technologies with constantly updating technical opportunities into a continuous process of ecological education.

The necessity of integration of modern information and traditional technologies of education while teaching chemical and biological subjects in conditions of the new information and technology environment to form a chemical-ecological culture of students has been proved.

5. The criteria (indicators) of the level of a chemical-ecological culture of students through information technologies in project activities when studying chemical-biological subjects have been defined and theoretically justified: an educational criterion (quality of ecological knowledge, ability to generalize information on various natural and man-made situations regarding a chemical component); a motivational and action-related criterion (interest in studying ecology; participation in various olympiads and projects of the ecological direction); emotional-sensory criterion (respect for nature; awareness of the necessity to save health and conserve energy).

**The theoretical significance of the research.**

1. The interpretation of the term “chemical-ecological culture” concerning students of secondary comprehensive institutions has been elicited. The pedagogical reasonability of forming a chemical-ecological culture of students through information technologies in project activities has been scientifically substantiated.

2. A pedagogical model of forming a chemical ecological culture of students through information technologies in project activities has been developed and justified. This model may serve as an addition to the theory of ecological education and upbringing in the new information educational environment.

**The practical significance of the research** is that a complex scientific and methodological support on the studied problem has been developed, including

materials programming the experimental work; training manuals for teachers “Forming a chemical-ecological culture of students in project activities”, “Forming a chemical-ecological culture of students through educational quests”, programs of extra-curricular courses. The results of the research will be useful for chemistry and biology teachers when forming a chemical-ecological culture of students of 7-11 grades. The materials and the results of the research may be used by teachers of various schools, institutions of additional education, and further training of representatives of the teaching profession.

**Authenticity and validity of the received research results** are ensured by a consecutive reliance on the modern methodology of the scientific cognition; a proper realization of initial theoretical considerations, concepts, and terminology of the research; compliance of the logic and research methods with its purpose, subject and tasks; the implementation of the research inseparably from the practical activity of the author; the consistency of the conclusions with the modern scientific visions of the role of information technologies in the modernization of the general education; the duration of the research, a close connection with the pedagogical practice and variation of the experimental-research work; the representativeness of the research sample, thorough long-term verification of the research hypothesis.

**Testing and adopting of the research results** were accomplished through participation at international, all-Russian, regional conferences, at the meetings of the faculty of the chemical education of Kazan Federal University, at the meetings of methods councils of chemistry teachers in Moskovskiy and Kirovskiy districts of Kazan city, at August conferences of science teachers of Kazan city and in the course of long-term teaching practice at school.

The main features, ideas, research results were reported at 7 scientific and scientific-practical conferences of different levels in Russia and abroad: international ones (Astrakhan, 2018, Valencia, Spain, 2018, Kazan 2019, St Petersburg, 2016, 2018, 2019, Shaulyai, Lithuania, 2015, etc.).

The main results have been published in the press, including the journals recommended by HCC of ME&S of the RF “Modern Knowledge-intensive technologies” and “Modern Problems of Science and Education”, “Chemistry at school”, as well as in foreign scientific journals and publications, indexed in the databases Web of Science and Scopus. Overall, 28 works have been published which include 759 printed pages. The published author’s teachers’ tools are tested at schools of Tatarstan (MBEI “Gymnasium №122 named after Zh.A. Zaitseva” of Moskovskiy district of Kazan City, MBEI “Gymnasium №4” of Kirovskiy district of Kazan City, MBEI “SCS № 151 affording intensive study of certain subjects” of Kirovskiy district of Kazan City, etc.).

The innovative idea of forming a chemical-ecological culture through information technologies, realized in the school practice, has been approved by the City Education Board, a methods council of science teachers of Kazan city, and is used at schools.

The author’s **private participation** includes receiving scientific results which have been stated in the thesis and published in printed works, as well as the

development of scientific propositions and research ideas. Many years of work experience as a biology and chemistry teacher, the leader of the regional methodological association of science teachers of Moskovskiy district of Kazan city, multi-year experience of working in the municipal methodological association of science teachers of Kazan city, as well as in the republican scientific and methodological association of chemistry teachers (professors) of the Republic of Tatarstan.

**The framework of the thesis submitted for the defense:**

1. The chemical-ecological culture of students of comprehensive institutions reflects in its correlation a chemical and ecological-legal literacy regulating human and natural activity, ensuring quality of the natural environment in conditions of a post-industrial information society. Structurally it includes fundamentals of eco-humanistic values, conservation competency, chemical-ecological literacy, basic knowledge about the rules of behavior in conditions of natural and man-made emergency situations, fundamentals of the culture of energy-saving in life and at school, abilities to think in the ecological aspect, which are formed in the process of general ecological education.

2. In project activities of chemical-ecological education the pedagogical conditions of the effective forming of a chemical ecological culture through information technologies are **extra-curricular courses based on multi-media and distant technologies, internet-technologies, electronic educational resources**, aimed at forming a chemical-ecological culture and encouraging self-independent work regarding the specificity of the region and the integrity of natural eco-systems, optimal updating of the content of the preparation in chemical-biological subjects in accordance with the possibilities of information technologies in project teaching with the purpose of forming a system of knowledge regarding ecologically safe actions; taking into account age and individual characteristics of students, their interest to information technologies when developing study and research projects promoting health-saving and energy conservation, preventing natural and man-made emergency situations regarding a chemical component, enforcing of the reflexive character of ecologically safe actions in the natural and virtual environments.

3. A pedagogical model of forming a chemical-ecological culture of students through information technologies in project activities includes seven units where:

- *at the functional target level* are revealed the content and the structure of a chemical-ecological culture, are defined the purpose, the objectives, the functions of its forming through information technologies in project activities;
- *at the substantial level* are fulfilled the selection and the structuration of the contents of the preparation in chemistry, biology, ecology following the pedagogical possibilities of information technologies in the system of forming a chemical-ecological culture of students;
- *at the theoretical level* are justified approaches, principles, pedagogical conditions and a model of forming a chemical-ecological culture of students through

information technologies in project activities in the course of learning chemistry, biology, ecology;

- *at the technological level* is substantiated the integration of traditional teaching technologies with information technologies in the process of forming a chemical-ecological culture of students in the course of learning chemistry, biology, ecology;
- *at the methodological level* is worked out the optimal usage of extra-curricular courses based on information technologies in project activities, which are aimed at forming a chemical-ecological culture and encouraging students' self-independent work regarding the specificity of the region and the integrity of natural ecosystems;
- *at the monitoring and evaluation level* are defined criteria and their indicators allowing to detect skill levels of the chemical-ecological culture of students through information technologies in project activities.

4. The criteria and indicators of the skill levels of the chemical-ecological culture of students through information technologies in project activities are as follows: an educational criterion (quality of ecological knowledge; abilities to generalize information on different situations of natural and man-made character regarding a chemical component), a motivational and action-related criterion (interest in learning ecology); participation in ecological olympiads and projects), an emotional-sensory criterion (respect for nature, awareness of the necessity of life-saving and energy conservation).

**The structure of the thesis.** The work consists of an introduction, two parts, a conclusion, a list of literature used, containing 195 publications of Russian and foreign authors, 3 attachments, 27 drawings, 5 tables. The total volume without attachments includes 164 pages. The conclusion represents common outcomes and results of the research explaining the solution of the problems defined.

## THE BASIC CONTENT OF THE THESIS

*The introduction* reveals the relevance of the theme, to which extent it has been developed, the apparatus criticus of the research, the novelty, the theoretical and practical significance, the main propositions submitted for the defense.

*In the first part* titled "Theoretical bases of forming a chemical-ecological culture of students through information technologies in project activities " are revealed the terms "culture", "ecological culture", "chemical-ecological culture", "chemical-ecological competence", is specified the term "modern information educational environment", are elicited the content and the structure of a chemical-ecological culture, are revealed the psychological and pedagogical grounds of its formation in conditions of the new information and educational environment of the chemical-ecological education; is elicited the role of information technologies and project activities in the process of forming a chemical-ecological culture of students.

The analysis of modern pedagogical literature and the content of FSES indicate that in modern social-economic conditions an ecological culture is a requirement of the educational preparation of students, e.g. an ideal norm of an educated person, who masters an eco-systemic educational model of forecasting ecological risks for health

and life safety in conditions of quick changing of the ecological quality of the environment.

Based on the systems analysis of the profile literature is defined the role of chemical knowledge in understanding the essence of patterns taking place in natural and man-made eco-systems regarding the role of chemistry in the negative influence on the environment, as well as in the monitoring of anthropogenic contamination and decontamination of natural and technogenic environments; the necessity to ecologically and safely manage chemicals, a larger scale usage of which is growing in everyday life and sectors of the national economy (food, beauty, building industries) in energy-saving conditions. It defines the importance of a chemical aspect of the systemic notion "ecological culture of a personality" and requires forming a chemical-ecological culture as its important component.

It is determined that a chemical-ecological culture reflects in its correlation chemical and ecologically-law literacy on the regulation of the activity of human and nature, ensuring the quality of the natural environment in conditions of a post-industrial information society. It contributes to the development of the inner feeling of responsibility and duty concerning all living things.

A chemical-ecological culture of a student, being an element of an ecological culture and general culture of a personality shows itself in the ecological education, respect for nature, practical participation in the improvement of the environmental management regarding chemical-ecological literacy, as well as its role in the ecological safety of a personality, in the state of protection against the negative natural and anthropogenic influence. The latter supposes mastering the bases of chemical safety, life-saving, and energy conservation. The defined stable connections in its content in combination with the review and analysis of the modern requirements to education permitted to meaningfully reveal its structural components. These are eco-humanistic values, environmental competency, chemical-ecological competency, chemical ecological literacy, basic knowledge of the standards of behavior in conditions of natural and technogenic emergencies, bases of the culture of life-saving, bases of the culture of energy conservation in everyday life and at school, thinking skills of the ecological focus, which are formed in the process of general chemical-ecological education (in the course of curricular and extra-curricular activity (see attachment 1).

The analysis of modern pedagogical literature indicates that in conditions of the new information and educational environment forming a chemical-ecological culture through information technologies in project activities supposes forming of relevant personality qualities when applying the whole set of software-technological means including the internet which is combined in the system of collection, storage, processing and distribution of information.

It has been established that the use of electronic educational resources, multimedia, distant, internet and other computer technologies as elements of information technologies in teaching allows to harmoniously and in a focused manner integrate the extension of project self-independent work of students into the learning

process. It is important that these technologies permit to combine gaming and learning activities.

*In the second part* of the thesis titled "Experimental work on forming a chemical-ecological culture of students in the course of learning chemistry and biology" have been established approaches and principles, elicited pedagogical conditions, developed a pedagogical model of forming a chemical-ecological culture of students; has been established integrity of modern information and traditional technologies of teaching chemistry and biology in conditions of the new information educational environment, including project education; has been given a technique and technology of the organization and carrying out the diagnostic and forming phases of the experimental research; has been given evaluation, analysis and data review with the use of the methods of mathematical statistics for the proof of the experiment conclusions.

Forming a chemical-ecological culture of teenagers in the course of learning chemical-biological subjects through information technologies requires a personality-oriented, integrative and environmental approach.

A personality-oriented approach signifies a shift in focus from accumulating of ecological knowledge, skills, and habits on forming a chemical-ecological culture of a personality possessing environmental competence skills in health-saving and energy conservation, habits of safe chemical-ecological activity at school and in everyday life. The approach supposes forming a personality capable of self-determination concerning ecologically-safe actions, creativity in the field of nature conservation. It helps to create conditions for the development of the ability of students to critical comprehension of their level of a chemical-ecological culture.

An environmental approach permits to organize educational activity of a teacher on the methodological basis where the environment is a means of forming a chemical-ecological culture of a personality. An environmental approach, where the concept "educational environment" is the basic one, permits to consider the new information educational environment as a pedagogical phenomenon in project learning of chemical-biological disciplines through information technologies. Thus, the principles of taking into account the specifics of the new information educational environment and life-saving are realized.

An integrative approach fulfills a systemically important function: organizationally it supposes integration of purposes and objectives of teachers and students in the activity on forming a chemical-ecological culture, cooperation of teachers of chemical-biological subjects and IT teachers; substantially it assumes integration of ecological education and chemistry training; technologically it supposes integration of information technologies, project teaching and traditional science teaching aimed at the effective forming of a chemical-ecological culture of students. In the approach is realized the compliance of the content of the pedagogical conditions and the model of forming a chemical-ecological culture with its purposes, as well as the principles of the consistency of knowledge, continuity, and succession. The use of the above-mentioned approaches and principles in forming a chemical-ecological culture of students has permitted to achieve succession, integrity, and

coordination in the system of continuous ecological education in conditions of the new information educational environment including project teaching.

To effectively form a chemical-ecological culture it is necessary to provide pedagogical conditions for the use of modern information technologies in project activities, aimed at upbringing self-determination among students regarding ecologically safe actions. The research has permitted to sort out and establish them.

The first condition is the use of extra-curricular courses based on multimedia and distant technologies, internet-technologies and electronic educational resources, aimed at forming a chemical-ecological culture and stimulating students' self-independent work taking into account the specificity of the region and the integrity of natural ecosystems. Its essence is that the logic of designing extra-curricular courses may be defined proceeding from the analysis of interaction in the closed system: nature – human health – artificial environment – nature. At the same time, it is necessary to make an emphasis on the impact of the artificial environment created by humans (including information technologies) on our health and to stress out the systematization of knowledge in chemical-biological subjects while doing applied exercises of the ecological content regarding the specificity of the region and integrity of natural ecosystems. The following parts are suggested for the systematization of the exercises: regional problems of the natural environment, food problem of the region and pesticides, chemistry in everyday life, home medicines, synthetic detergents, and natural eco-systems.

The second condition is an optimal update of the content of the preparation in chemical-biological subjects regarding the possibilities of information technologies in project teaching with the purpose of forming the system knowledge concerning ecologically safe actions.

Its essence is that while teaching chemical-biological subjects the computer must become a tool of teaching project activity (curricular and extra-curricular) of students (not only a teacher's means of working). It is supposed to use digital educational resources in the school practice (on CD and on the internet), certain accessible tasks on modelling chemical and biological phenomena and a critical review of the created models, acquaintance with the role of the computer modelling in modern science and technology, exposing and solving ecological problems. Expansion of possibilities of a school experiment in project activities in ecology due to digital chemical laboratories, extra-curricular events on chemical bases of ecological problems with the use of digital educational resources, multimedia for creating interactive presentations, digital cameras, and camcorders.

The third condition is taking into account the age and individual characteristics of students, their interest in information technologies when making projects on promoting life-saving and energy conservation, preventing natural and technogenic emergencies. This condition assumes realization of subject-subject relations and personality-oriented teaching, attitude to a student as a subject of development and self-development, creating conditions for his self-realization through information technologies in project activities. Educational and research project tasks are meant for different age characteristics of students and are aimed at broadening their mind and

development of their interest to the issues of life-saving, energy-conservation and preventing emergencies, ability to do ecologically safe actions taking into account their age and up-bringing.

The fourth condition is strengthening of the reflexive character of ecologically safe actions in natural and virtual environments. This condition is given due to the fact that skills formed in the virtual world are not always adequate in respect of real objects and can be applied in real conservation activity. It requires familiarizing students with practical actions on nature conservation. It is possible to organize it using a chemical-ecological project method, case methods, chemical and ecologically-oriented quests, and competency-oriented tasks. At the same time, things that contribute to immersing into ecological problems are their virtual models, e.g. original computer “games”, allowing them to evaluate the impact of the technosphere on nature. Strengthening of the reflexive character of ecologically safe actions calls forth positive features of teaching, combining immersing into the virtual environment with the practical activity on nature conservation.

The pedagogical potential of information technologies in the process of forming a chemical-ecological culture of students includes the following: a) expansion of project extra-curricular self-independent work, which at most contributes to conscious mastering of ecologically safe natural and scientific activity regarding the specificity of the region and the integrity of natural ecosystems; b) a possibility to organize interactive ecologically-oriented teaching with the use of dynamic images of studied natural and scientific objects; c) visual opportunity of a scientific prognostication of remote consequences of ecological problems, whose solving requires action skills in critical conditions as well as vast science knowledge; d) an opportunity of a harmonious integration of information technologies with constantly updated technical possibilities into a continuous process of ecological-chemical education.

The pedagogical model presents a system of interrelated levels which realizes the elicited pedagogical conditions.

The functional target level includes the basic purpose of the developed process in correlation with the requirements of the Federal State Educational Standard of the new generation, the objectives of forming, the functions and directions of the activity. The theoretical-methodological level is defined with the whole set of methodological approaches (personality-related, integrative and environmental ones), principles and pedagogical conditions.

The versatility and flexibility of the model are defined by the organizational, substantial, technological, and methodological levels, developed based on the consistency of knowledge, continuity, and succession; taking into account the specific character of the new information educational environment, including information technologies and project activity; life-saving and suggested pedagogical conditions. The methodological level includes an optimal usage of the developed extra-curricular courses, project themes based on information technologies regarding the specificity of the region and the integrity of natural ecosystems, teaching aids

created for these courses, case tasks, chemical-ecological quests and competency-oriented tasks.

The criterion-assessment level includes performance criteria: an educational criterion (quality of chemical-ecological knowledge; skills of summarizing information on natural and technogenic emergencies regarding a chemical component), a motivational-activity criterion (interest in learning ecology; participating in ecological olympiads), an emotionally-sensory criterion (respect for nature, awareness of the need to save life and conserve energy) as well as the result (conscious actions on nature conservation, life-saving, chemical-ecological safety in everyday life and at school, conserving energy, preventing natural and man-made emergencies regarding a chemical component). Based on the feedback, it is possible to update the content of this section.

The experimental research is devoted to approbation of the developed pedagogical model, presented in application 1. The difficulty consisted in the fact that all mentioned above is characteristic for a chemical-ecological culture. We consider the possibility of its forming in conditions of the new information educational environment based on extra-curricular courses encouraging students' self-independent work, projects regarding the specificity of the region and the integrity of natural ecosystems, use of electronic educational resources, multimedia presentations, digital laboratories, cameras and camcorders, cases, quests, and virtual models with a chemical-ecological content.

This process is shown in conditions of teaching chemical-ecological subjects in 7-11 grades. 6-graders also took part in the pedagogical search observation and questioning.

Three common characteristics have been chosen based on the theoretical research to define the efficiency of forming a chemical-ecological culture: educational, motivational-activity, and emotional-sensory criteria (6 evaluation criteria, table 1). In the main experimental research participated two groups of students – control group (CG) consisting of 56 students and experimental group (EG) including 55 students.

This long-term experiment had a complex character. During the qualitative and quantitative analysis of the research results, a median criterion was used for checking statistical hypothesis (for the level of significance, a=0,05, and one degree of freedom).

The preparation and organization of the experimental work included the following stages: diagnostic, didactic and final ones. Statistical methods of processing the research results were used following the set task.

The diagnostic stage was connected with the research of the skill level of the students´ interest in learning ecological issues and factors influencing its development when learning botany, zoology, and chemistry. Students of 7-11 grades participated in the questionnaire, which consisted of two parts (detecting interest in environmental issues and evaluating the influence of different factors on interest in environmental issues). Three levels have been elicited: an average level (54%) and a low level prevailed in the EG (33%) and the CG (35%). It has been elicited that the

greatest influence on developing a students' interest in environmental issues is exerted by biology teachers, leaving behind such factors as periodicals, parents and friends. Besides, a modern information competence was defined among 70 biology and chemistry teachers (ICT-competency). It differentiates into a base one (invariant of knowledge, skills, habits, and a work experience with modern information technologies of a common purpose in education) and a subject-oriented (an ability to use and readiness to apply modern special information resources in teaching a subject).

In gymnasiums and at the school which participated in the experimental research work on creating a modern information technology environment like the introduction of electronic registers, equipment of the classrooms with laptops, computers, interactive boards, digital laboratories, technology training for teachers has been carried out.

To question and evaluate the level of information competency of school teachers participating in the experimental work were used questionnaires placed for similar purposes on the Internet. Stable positive dynamics in the level of information competency of subject teachers participating in the experimental work were observed.

It has been established that a teacher is considered competent in the field of modern information technologies and ready to form a chemical-ecological culture of students through information technologies if he or she: regularly uses digital educational resources, is fluent in search of internet-resources for educational and upbringing purposes; develops and applies ready computer multimedia presentations, uses computer tests and video materials in teaching, is able to use techniques of digital laboratories; manages the educational and upbringing process through computer programs.

The didactic stage included the realization of the developed pedagogical conditions, implementing extra-curricular courses with an emphasis on disclosing the role of chemistry in environmental protection, research projects of a chemical-environmental character, projects promoting health-saving and energy conservation, preventing emergencies, and educational-methodological maintenance in general (including information technologies), evaluating the efficiency of forming a chemical-ecological culture following the criteria. I.Z. Skovorodkina's and S.N. Glazachev's questionnaires eliciting the students' skill level of environmental knowledge, S.N. Glazachev's personality test and authors' tests were used. When analyzing intermediate results a possibility of a gradual transfer on a higher level of formation of a chemical-ecological culture was established, starting with secondary school grades.

At the final stage of the experiment significant breakthroughs and differences in the observed targeted result were received in the EG and the CG. Figure 1 represents a diagram of the main experimental research.

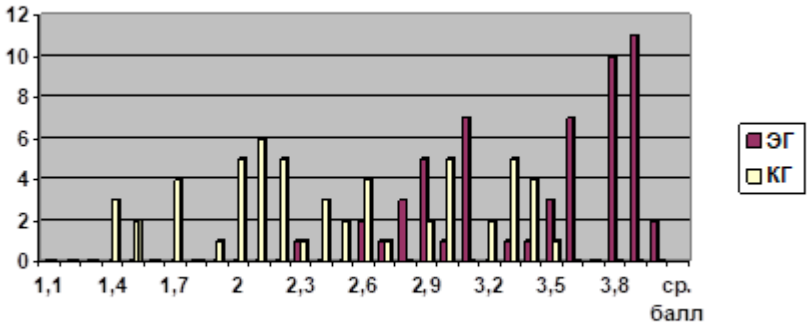


Fig.1. Distribution of values of the students' conscious actions regarding their frequencies in the experimental and control groups (final diagram)

Table 1

The efficiency of forming a chemical-ecological culture of students through information technologies in project activities

| Educational level rates | % of students whose level has increased | | Motivational-activity level rates | % of students whose level has increased | | Emotional-sensory level rates | % of students whose level has increased | |
|---|---|---|---|---|---|---|---|---|
| | EG | CG | | EG | CG | | EG | CG |
| Quality of ecological knowledge | 62 | 18 | Interest in studying ecology | 58 | 20 | Respect for nature | 72 | 20 |
| Abilities to summarize information on natural and man-made emergencies taking into account a chemical component | 58 | 16 | Participating in ecological olympiads and projects | 48 | 16 | Awareness of the necessity of life-saving and energy conservation | 40 | 18 |
| Dynamics on the basic criteria of efficiency in forming a chemical-ecological culture | | | | | | | | |
| Educational level | 60 | 17 | Motivational-activity level | 53 | 18 | Emotional-sensory level | 56 | 19 |
| A targeted result is observed | | | | | | | | |
| Conscious actions on nature conservation, health-saving and energy conservation, ecological and chemical safety in everyday life and at school, preventing natural and man-made emergencies regarding a chemical component | | | | | | | 56 | 18 |

A significant rate growth has been observed among the students of the EG compared with the CG: the quality of chemical-ecological knowledge has increased among 62% (EG) and 18% (CG), abilities to summarize information on natural and man-made emergencies regarding a chemical component – 58% (EG) and 16% (CG); interest in studying ecology – 58% (EG) and 20% (CG); participating in ecological olympiads – 48% (EG) and 18% (CG). All in all, it was managed to transfer on a higher level of conscious actions on nature conservation, life-saving and energy

efficiency, chemical-ecological safety in everyday life and at school, preventing natural and man-made emergencies regarding a chemical component 56% students of the EG (18% of students of the CG).

The result has been received due to a purposeful realization of the developed pedagogical model of forming a chemical-ecological culture through information technologies in project activities. It is worth mentioning a certain conditionality of the received results connected with the specificity of the pedagogical science.

The analysis of solving the objectives of the research indicates the achievement of the purpose and the proof of the proposed hypothesis that permits the formulation of the main conclusions presented below.

1. An important structural component of an ecological culture is a chemical-ecological culture reflecting in its correlation a chemical and environmental-law competence concerning the regulation of the activity of the human and nature, ensuring the quality of the natural environment in conditions of a post-industrial, information society.

2. It has been established that in conditions of the new information and educational environment forming a chemical-ecological culture through information technologies in project activities supposes the formation of relevant personality qualities as a result of implementing a whole set of software and technology tools, including the internet, united in the system of collecting, keeping, handling and disseminating the ecological information.

The pedagogical potential of information technologies while forming a chemical-ecological culture of students in the system of chemical-biological education has been elicited. It assumes the extension of the self-independent work contributing to conscious learning of ecologically safe activity regarding the specificity of the region and the integrity of natural ecosystems; interactive ecologically-oriented teaching with the use of dynamic images of the studied objects; visual scientific foreseeing of distant consequences of environmental problems, whose solving requires action skills in critical situations as well as extensive natural scientific knowledge, the integrity of information technologies with constantly updating technical opportunities into a continuous process of ecological education.

The necessity of integration of modern information and traditional technologies of education while teaching chemical and biological subjects in conditions of the new information and technology environment to form a chemical-ecological culture of students has been proved.

3. The basic directions for the activity in forming a chemical-ecological culture of students through information technologies in project activities in the course of studying chemical-ecological disciplines are based on personality-oriented, integrative and environmental approaches regarding the principles of the consistency of knowledge, continuity and succession, concerning the specifics of the new information educational environment, and life-saving.

4. Certain pedagogical conditions ensuring the efficiency of forming a chemical-ecological culture of students through information technologies in project activities: the use of extra-curricular courses based on multimedia, distant, internet-

technologies, electronic educational resources, aimed at forming an ecological culture and stimulating students' self-independent work regarding the specificity of the region and the integrity of natural ecosystems, an optimal updating of the content of preparation in chemical-biological subjects in accordance with the possibilities of information technologies to form the consistency of students' knowledge with regard to ecologically safe actions, concerning the age and individual characteristics of students, their interest in information technologies when designing projects promoting health-saving and energy conservation, preventing natural and man-mad emergencies; strengthening of the reflexive character of ecologically safe actions in natural and virtual environments.

5. A pedagogical model of forming a chemical-ecological culture of students through information technologies in project activities of a chemical-ecological education has been developed and theoretically established. Its realization permits to purposefully form a chemical-ecological culture of students, using at most the pedagogical potential of information technologies.

6. Theoretically established criteria of efficiency of forming a chemical-ecological culture of students through information technologies in project activities of a chemical-ecological education have been experimentally confirmed: e.g. an educational criterion (quality of ecological knowledge, abilities to summarize data on natural and man-made emergencies), a motivational-activity criterion (interest in studying ecology, participating in ecological olympiads), an emotional-sensory criterion (respect for nature, awareness of the necessity of life-saving and energy-conservation).

**The main content and research results are represented in the following publications of the author:**

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