FORMAÇÃO AMBIENTALMENTE ORIENTADA NO PROCESSO DO PROGRAMA PROFISSIONAL PARA ESTUDANTES**ENVIRONMENTALLY-ORIENTED TRAINING IN THE PROCESS OF THE PROFESSIONAL PROGRAMME FOR STUDENTS****ЭКОЛОГИЧЕСКИ ОРИЕНТИРОВАННОЕ ОБУЧЕНИЕ В ПРОЦЕССЕ ПРОФЕССИОНАЛЬНОЙ ПРОГРАММЫ ДЛЯ СТУДЕНТОВ**

DLIMBETOVA, Gaini K.^{1*}; ABENOVA, Saulet U.²; MANDYKAYEVA, Almagul R.³;
STUKALENKO, Nina M.⁴; BAKIROVA, Kulzhakhan S.⁵;

^{1,2,3} L.N. Gumilyov Eurasian National University, Department of Social Pedagogics and Self-Knowledge, Nur-Sultan – Republic of Kazakhstan

⁴ Branch of JSC "National Center for Professional Development "Orleu"", Institute of Professional Development in Akmola region, Kokshetau – Republic of Kazakhstan

⁵ Abai Kazakh National Pedagogical University, Department of Geography, Ecology, and Tourism, Nur-Sultan – Republic of Kazakhstan

* Correspondence author
e-mail: gainid@mail.ru

Received 04 September 2019; received in revised form 20 October 2019; accepted 24 October 2019

RESUMO

Os processos químicos formam a base para a existência de toda matéria viva e inanimada. Além disso, a base para o desenvolvimento do mundo material e a determinação das características dos objetos e materiais pertence à área de assunto do processamento químico. Nesse sentido, o uso de recursos naturais torna-se um problema urgente, a fim de determinar a possibilidade de sua máxima conservação com um uso mais intensivo. Para os estudantes da Faculdade de Química, isso é especialmente importante, pois são eles que implementam os processos de produção química que causam os danos mais significativos ao meio ambiente. Além disso, a principal tarefa da ecologização é minimizar os danos recebidos. Manter o equilíbrio a esse respeito é a relevância da pesquisa. A inovação da pesquisa é determinada pelo fato de que, pela primeira vez, a competência ambiental é considerada um processo de futuro apoio profissional ao trabalho na indústria química. No processo de pesquisa, foi utilizado o método longitudinal que incluiu um experimento paralelo do qual participaram os grupos controle e experimental. Os autores assumem que a competência ambiental deve ser determinada no início do trabalho de cada profissional e influenciá-los aplicando conhecimentos especializados. O artigo revela as características metodológicas e essenciais da aplicação da competência ambiental na formação profissional de estudantes veteranos. O uso da abordagem proposta permitirá às autoridades regionais exercer controle operacional e modelar os cenários para o desenvolvimento dos processos de ecologização do território devido à ecologização da educação, levando em consideração as mudanças ambientais externas.

Palavras-chave: *competência ecológica, tomada de medidas, treinamento, estudantes, especialidade química.*

ABSTRACT

Chemical processes form the basis for the existence of all living and inanimate matter. Moreover, the basis for the development of the material world and the determination of the objects' and materials' features belongs to the subject area of chemical processing. In this regard, the use of natural resources becomes an urgent problem in order to determine the possibility of its maximum conservation with more intensive use of it. For students of the Faculty of Chemistry, this is especially important since it is they who implement the processes of chemical production that cause the most significant harm to the ecological environment. In addition, the main task of ecologization is to minimize the damage received. Maintaining balance in this regard is the relevance of the research. The novelty of the research is determined by the fact that for the first time environmental competence is considered as a process of future professional support of work in the chemical industry. In the process of research, it was used the longitudinal method, which included a parallel experiment,

in which participated the control and the experimental groups. The authors assume that environmental competence should be determined at the beginning of the work of each professional and influence them by applying specialized knowledge. The article reveals the methodological and essential characteristics of applying environmental competence in the professional training of senior students. The use of the proposed approach will allow the regional authorities to exercise operative control and model the scenarios for the development of the processes of ecologization of the territory due to the ecologization of education, taking into account the external environment changes.

Keywords: *ecological competence, taking measures, training, students, chemical specialty.*

АННОТАЦИЯ

Химические процессы составляют основу существования всего живого и неживой материи. Вместе с тем, основа развития материального мира и определение свойств объектов и материалов принадлежит предметной области химического процессинга. В связи с этим, использование природных ресурсов становится насущной проблемой для того, чтобы определить возможность максимального его сохранения при более интенсивном его использовании. Для студентов химического факультета это особенно актуально, так как именно они реализуют процессы химического производства, которые наносят экологической среде наибольший вред. Вместе с тем, основная задача экологизации состоит в том, чтобы минимизировать полученный вред. Сохранение равновесия в данном ключе и составляет актуальность проводимого исследования. Новизна исследования определяется тем, что впервые экологическая компетенция рассматривается как процесс будущего профессионального обеспечения работы в химической промышленности. В процессе исследования использовался продольный метод, который включал параллельный эксперимент, в котором участвовали две группы: контрольная и экспериментальная. Авторы определяют, что экологическая компетенция должна быть определена в начале работы каждого профессионала и влиять на применение им специальных знаний. В статье раскрывается методологическая и сущностная характеристика применения экологической компетенции в профессиональной подготовке студентов старших курсов. Использование предложенного подхода позволит региональным властям осуществлять оперативный контроль и моделировать сценарии развития процессов экологизации территории вследствие экологизации образования с учетом изменений внешней среды.

Ключевые слова: *экологическая компетентность, принятие мер, обучение, студенты, химическая специальность.*

1. INTRODUCTION

A characteristic feature of the last century was the impetuous unrestrained striving for economic and technological development. Ignorance, and in most cases – ignoring the laws of nature leads to terrible consequences, the proof of this is the environmental crisis of our time, which is caused by the depletion of vital natural resources (Lee *et al.*, 2016). Planetary cataclysms, such as increased volcanic activity or icing, soil degradation or desertification of fertile lands, snowballed a significant change in the biosphere and from time to time put the human community before the choice of dying or changing lifestyles: migrating, resorting to tillage and switching to settled or introduce some new forms of management (Lowan-Trudeau, 2017). But until XX century, on Earth, people did not face such changes, as a result of which nature would find itself in a state of unstable equilibrium, and people – before the choice between death and a fundamentally different way of being (Richardson *et al.*, 2016;

Maslennikov *et al.*, 2017; Akhmetshin *et al.*, 2019a; Akhmetshin *et al.*, 2019b).

Over the past 50 years, the deterioration of most ecosystems in the biosphere can be observed, catastrophic depletion of soil, mineral resources, a significant decrease in bioproductivity and biodiversity, unprecedented pollution of the Earth's surface; hydrosphere and atmosphere are associated with the intensive growth of the planet's population and the development of scientific and technological progress (Lopes *et al.*, 2014). It is the need to meet the increasing needs of human society led to a massive expansion of the volume of economic activity, changes in the proportions of the world economy, technique and technology, production capacity, product range, production, and personal consumption. The world has developed production and consumption patterns that do not meet the conditions for the healthy coexistence of man and nature (Kim *et al.*, 2017; Rusko and Lumnitzer, 2017; Isakova, 2018).

One of the most potent levers out of the

crisis, which has been developed in the relationship of man with nature, is environmental education. Noting the social orientation of environmental problems, N. Reimers pointed out that one of the ways out of the environmental crisis is regulated co-evolution in the "society-environment" system. At the present stage, mankind should understand its inalienability from nature, revise its principles and beliefs, assess the truth formulated 400 years ago by the English philosopher F. Bacon "We cannot control nature except by submitting to it" (Flagg and Bates, 2016; Genc *et al.*, 2018; Grishaeva *et al.*, 2018).

Due to the expansion of human activity, social ecology is actively developing – a science that studies the patterns of society's impact on the biosphere and changes in it, affects every single person and society as a whole. The goal of social ecology is the formation of knowledge about the harmonious relationship between society and nature, the principles of rational environmental management, worldview beliefs that nature that surrounds us is our home, and its preservation is a condition for the survival of humanity. Environmental consciousness and culture are formed by using the principles and methods of environmental education and training (Grodzinska-Jurczak, 2000; Adler *et al.*, 2016; Manzheley, 2016; Kaigorodova *et al.*, 2017).

An essential role in the awareness of a person of their place in nature belongs to environmental ethics. Ecological ethics is the study of the fundamentals of relations with nature, based on the recognition of the moral status of nature, high appreciation of its values, respect for the right to the harmonious existence of all components of natural ecosystems (Pryor *et al.*, 2005). The subject of ecological ethics is the studies of the foundations of the moral attitude of a person to nature, the analysis of stereotypes of human behavior that lead to environmental problems, the search for ethical ideals of the relationship of man to nature that will help overcome the ecological crisis (Lee, 2007). Ecological ethics is designed to identify new principles and new approaches to relationships in the "man-nature" system, new behaviors that will contribute to solving environmental problems. Ethics in an ecological sense is a restriction of freedom of action in the struggle for existence. Ecological ethics is based on the principle of the 20th-century German philosopher Albert Schweitzer - the principle of reverence for life, the central idea of which is the postulate "all living beings are worth living." The great humanist wrote: "The more we look into nature, the more

we realize that we are connected with everything living in nature. A person cannot live only for themselves - we must realize that any life is a value", because ethics, in their opinion, is "a person's unlimited responsibility for everything living on the Earth" (Mueller, 2009; Marekha and Omelyanenko, 2017).

Man is the only creature that can control and manipulate the environment, destroy or preserve it. Knowledge of the consequences of environmental impact is an essential element of human culture. The present and the future are more determined by a person. In turn, the actions that a person will do are determined by their education. In order to understand the essence of the concept of ecological culture and its components, it is worth considering the concept of culture and its relationship with nature in a general sense (Fateev and Fateeva, 2016; Zeleeva and Asafova, 2016; Sitarov and Urekeshova, 2017; Cherdymova *et al.*, 2018).

The goal of the experiment's formative stage, which lasted during 2015-2018, was the practical verification of the effectiveness of the technology to form an environmental culture of students of the chemistry faculty in the process of professional training (Sasongko *et al.*, 2019).

2. LITERATURE REVIEW

The realization of the goal and main tasks of the formation of ecological culture is based on the principles of the interrelation of theoretical knowledge with the practical activity of students; the inclusion of ecological aspects in the structure of subject, special generalizing topics; the combination of classroom activities in nature (excursions, field camps, tourist trips); the use of problematic teaching methods (role-playing games, environmental clubs, research activities, experiments, observations); a combination of classroom and extracurricular environmental work (Kimmerer, 2012; Aleksandrova *et al.*, 2019; Sagiyeveva *et al.*, 2018).

The future chemist should be able to assess historical and modern processes and problems in the life of the country, trends in educational development, have high mortality, possess organizational and professional skills, professionally solve problems according to their social consequences, be fluent in a foreign language, use one of the additional foreign languages professionally (Schleicher, 1989).

The main production functions that the future chemist should possess include: a

predictive one, which implies awareness of environmental situations, the ability to solve them, the preparation of laboratory instruments, utensils, reagents for chemical analysis; technical - the ability to assess the pollution of the hydrosphere, atmosphere, biosphere; technological - the ability to take samples and conduct analyses of agricultural products, to make practical decisions to reduce environmental pollution (Gough, 2017). The content of production functions, which consist of the tasks and skills of future chemists, are presented in the formula of production functions, typical tasks of activity and skills that a chemist should have (Brown, 1992; Aliyeva *et al.*, 2016).

From the point of view of the issue that is solved in our research, it is significant that the characteristics of the age period of student chemists are the search for harmony in the natural world and the comprehension of one's own position in relations with him (Sofluau and David, 2018). At this age, the predominantly aesthetic, contemplative perception of nature is especially pronounced, the relation to which is objective in nature (Schleicher, 1975; Schleicher, 1989). Interaction with the natural world is carried out on the basis of mastering the technologies of aesthetic development of natural objects, namely: manifestations of sensual aesthetic susceptibility to them; individual semantic assessment of their life conditions; emotional responsiveness in situations of communication with them; and, finally, in the ability to find a cultural form of preserving and expressing one's impression of these objects (in drawings, poems, photographs, music) (Liu and Chai, 2012). Consequently, it is appropriate to note the role of excursions into nature, during which students through emotions can feel the beauty of nature, its uniqueness; there is an enrichment of the motives of a responsible attitude to nature and the development of environmentally literate behavior (Generalov, 1998). It is worth focusing on the fact that adolescence itself is associated with the formation of such personal qualities as responsibility, perseverance, frugality, benevolence, self-criticism, readiness to perform various tasks, which determine the result of harmonious interaction with nature and the formation of ecological culture (Anderson, 2008).

We share the opinion that the goal of modern vocational education is the appropriate preparation of chemists to implement rational activities aimed at protecting and improving the state of the environment, preventing civilizational threats and solving global environmental

problems associated with human activities (Harding *et al.*, 2018). Thus, the formation of the ecological culture of future chemists provides for the mastery of in-depth environmental knowledge, relevant environmental skills and abilities, due to the presence of motivation and value orientations regarding environmental activities aimed at preserving the environment, which are formed during the study of academic disciplines, expand and refined over many occupations and turning into beliefs (Gevorgyan and Adanallyan, 2009).

3. MATERIALS AND METHODS

In the course of professional training of future students of the Faculty of Chemistry, the level of formation of indicators of motivational, axiological, cognitive, reflective and practical criteria of ecological culture was diagnosed. In the process of research, it was used the longitudinal method, which included a parallel experiment, in which two groups participated: the control and the experimental. Their composition was identical in all control and neutral characteristics that could affect the consequences of the experiment.

Experimental and control groups were identified (the number of students, respectively, 152 and 163). Diagnostics covered students of the III and IV years of study. In the control groups (CG), the educational process took place according to the traditional program of studying environmental disciplines, and in the experimental groups (EG), the technology of forming an ecological culture was developed in the learning process. Comparison of both research objects was carried out both before the experiment and after it. This made it possible to compare the initial and final characteristics of the process of forming an ecological culture, namely, ecological knowledge, and motivation, value orientations regarding the nature, environmental awareness, and nature conservation activities of students of the chemical faculty, thus proving the effectiveness to introduce the proposed technology into the educational process.

According to the results of the input diagnostics, four levels of forming the criteria of ecological culture in the CG and the EG students (primary, medium, sufficient, high) were inserted. According to a specific structure of ecological culture, a questionnaire for students was developed, which was used to study the criteria for the formation of ecological culture among future students of the Faculty of Chemistry. The

questionnaire contained blocks of characteristics that should be evaluated by students at various stages of experimental work.

The first block of the questionnaire contained questions (positions 1-3), aimed at studying the prerequisites for selection by future chemists of professional activity. The second block (positions 4-5) is aimed at determining the importance of students' formed knowledge related to the performance of their professional duties. The third block of the questionnaire (position 6-7) was meant to research the level of awareness development of one's own involvement in environmental protection activities and the value orientations of the chemist, which have a positive effect on the process of ecological culture formation. The fourth block (position 8) was designed to determine the level of development of the relevant skills. The formative experiment was carried out in several stages. A significant place in the experimental work was occupied by the diagnosis of the level of motivation, the formation of relevant knowledge, skills, and personal qualities of students, which were carried out in two stages – at the beginning and at the end of the experiment. The level of formation of each of chemical faculty students' environmental criteria was evaluated on the basis of the developed indicators.

4. RESULTS AND DISCUSSION:

Let dwell on the evaluation of specific criteria. Thus, the motivational criterion envisaged the formation of a sustainable motivation for conscious environmental activity among future students of the chemistry department.

As can be seen from the data presented in Figure 1, students' motivation increases in the process of experimental work, which indicates a conscious choice of their future profession. To assess the level of motor development of the professional activities of students of the chemical faculty, we chose K. Zamfir's method in A. Rean's modification, based on the concept of external and internal motivation. Having an internal type of motor activity in itself is essential for the individual. With the external type of motivation, there is the desire to meet other needs, external to the content of the activity itself in the basis of professional activity. Most of the students indicated that they were seeking to preserve nature (0.84), where they will be able to participate in environmental protection measures (0.76), while they will be implemented precisely in

the field of ecology (0.72). Other motives are not so important (Table 1).

Severity indicators of each type of motivation (internal motivation IM, external positive motivation IPM, and external negative ENM) are calculated by the formulas (Equations 1-3). The results of the calculations are shown in Table 2.

The general motivational complex can be represented in the form of inequality: $IM (4,02) > IPM (2,73) > ENM (2,08)$. This inequality indicates that the motivational complex for the choice of the profession of students of experimental groups belongs to the optimal motivational complex. Thus, most of the students of the chemical faculty who took part in the experiment deliberately expressed a desire to preserve nature following internal motives.

Axiological criterion envisaged the development of awareness of the need for a responsible attitude to nature in the process of the professional activity. To check the level of formation of a specific list of value orientations, we have prepared scales containing indicators by the degree of importance and level of formation in the respondents' self-assessment (sections were taken twice – before and after the experiment. The results of valuable orientations formation are shown in Table 3.

In the course of the experiment, such value orientations as the realization that not only man but also every kind of animal and plant has the right to exist as a result of a long evolution (0.69-0.89), the ability to observe nature (0, 72-0.89), the improvement of their personal inner world on the feeling of human unindifference, dignity, care, mutual aid (0.71-0.88), the desire to preserve the flora and fauna (0.73-0.9), the desire to multiply the wealth of nature (0.7-0.88).

According to the cognitive criteria for the formation of ecological culture, it assumed the level of assimilation of ecological knowledge and its implementation in the process of professional activity, when the knowledge gained is transformed into ecosystem understanding. To check the level of formation of professional environmental knowledge among students, we have prepared scales that contain indicators of the level of formation of the relevant knowledge in the self-assessment of respondents from the experimental and control groups (sections were made twice – before and after the experiment). The results are shown in Table 4.

The level of formation of professional

environmental knowledge among students of experimental groups (Figure 2) for the experiment was the lowest with regard to knowledge concerning objects, phenomena, and environmental processes (0.64). After the experiment, the level of knowledge formation has changed significantly. Knowledge of the conservation of plant and animal world has reached a high level (0.92).

The level of knowledge on economic approaches to environmental protection remains insufficient, although, comparing with the initial, there is a tendency to growth (0.75 at the beginning of the experiment and 0.86 at the end) and knowledge on the protection of atmospheric air, water resources, soil (0, 76 at the beginning of the experiment and 0.86 at the end).

It is worth noting that among students there is a tendency to receive modern environmental education, which will contribute to the development of their professionalism.

The practical criterion covered the skills and abilities that contribute to the formation of ecological culture. The results of the dynamics of the level of professional (gnostic, design, constructive, organizational, communicative) skills formation necessary to form the environmental culture among students of the chemical faculty are shown in Figure 3.

Among the Gnostic skills after the experiment, then the ability to analyze and evaluate the state of the environment (0.9), analyze, select and apply optimally suitable research methods in professional activities (0.89) gained the highest development. The lowest level was gained by the ability to analyze the general ecological state of the region by indicator organisms (0.83), analyze the possibilities of ecological imbalance during professional activities (0.84), analyze economic losses from the air, water, and land pollution (0.84).

Design skills have gained positive dynamics throughout the experiment. The ability to develop proposals for the creation of natural protected areas (0.91), to develop recommendations for rationing and limiting the anthropogenic impact on the environment (0.89), to determine the types of economic losses from environmental pollution by enterprises (0.88) has gained unique development. However, in our opinion, students lack practical experience acquired in the course of their professional activities, as evidenced by the insufficiently formed skills to design trends and ways to accelerate progress and methods to neutralize negative phenomena (0.84) and

predict the dynamics and design a model of the state of the biosphere time and space (0.82).

Among constructive skills there is a positive trend in the development of such skills as choosing the most appropriate methods and ways to overcome the environmental crisis (0.71 at the beginning of the experiment and 0.9 after its completion), to realize the goals and objectives of developing an environmentally stable society by selecting information methods of environmental education (0.69 at the beginning of the experiment and 0.87 after its completion), determine the types, methods and stages of work for the organization of the system of environmental monitoring (0.68 at the beginning of 0.84 to experiments and after its completion). However, attention should be paid to the types and methods of environmental monitoring and the use of computer technology in assessing the state of the environment. In the block of organizational skills, the highest level of formation has been acquired by the ability to promote the formation of an environmental outlook (0.89), to carry out environmental protection measures (0.89), to encourage everyone to systematical, purposeful, continuous communication with the environment in the process of various activities (0.88).

Communicative skills have turned out to be the most developed, namely: to develop communication skills in a team (0.89), to participate in discussions and the choice of optimal solutions (0.9), to organize the work of a group of subordinates (0.87), to manage their emotions, behavior in time of communication with the leadership (0.9), to stimulate the interest of the younger generation in solving environmental problems of our time (0.88). This indicates that students are already ready to work in a team; that's why it is advisable to attract students to participate in public environmental associations, research work, environmental festivals, competitions, tourism. After the experiment, communication skills (0.89) and organizational skills (0.88) reach a high level of development.

The reflexive criterion (Figure 4) provided for the development of self-awareness, self-realization, which will help in future professional activity. Data analysis suggests that a significant part of students are aware of their own involvement in the implementation of environmental activities, without which it is impossible to guarantee the environmental safety of the environment and society. Among the self-realization types of own involvement in environmental protection activities, the largest

tendency for growth compared with the initial level during the experiment was: development of environmental responsibility (0.89), assessment of the environmental situation and implementation of environmental protection measures in accordance with environmental legislation (0.88), encouraging the younger generation to actively protect the environment through the formation of relevant value orientations, knowledge, intelligence skills (0.89). The summarized data on the levels of indicators' formation of the ecological culture of the chemical faculty students are presented in Table 5.

Thus, according to the motivational criterion high level was reached by 36.2% of the students of the experimental groups, whereas in the control groups – only 14.3%, sufficient – 44.6% and 40.1%, respectively, there has been a decrease in the medium – 16.0% and 36, 9% respectively and the initial level – 3.2% and 8.7%. The identified positive changes among the students of experimental groups indicate significant changes in the motivational sphere, the dominance of professionally oriented motives relating to nature, interest in solving modern environmental problems, the presence of environmentally valuable orientations and incentives to carry out professional activities.

According to the axiological criteria a high level was reached by 35.6% of the students of the experimental groups, 15.6% – by the students of the control groups, 46.5% and 38.8%, respectively, reached sufficient level, 14.5% and 37.3% – medium, and the initial level was reached respectively by 3.4% and 8.3%. These data indicate the formation of ideological environmental positions, which become vital principles, determine the nature of its activities as a future specialist in the field of ecology.

According to the cognitive criterion a high level was reached by 38.2% of the students in the experimental groups, 14.5% – students of the control groups, 43.6% and 40.2%, respectively – the sufficient level, 14.1% and 37.1%, respectively – the medium level, respectively – 4.1% and 8.2% – beginner. The data obtained indicate an increase in the volume of professional knowledge acquired by future specialists on ecology, environmental protection and rational environmental management, an understanding of the positive and negative anthropogenic impact on the environment, and understanding the causes of the current environmental crisis in the country (Pechancová *et al.*, 2019).

Thus, according to the reflexive criterion a

high level was reached by 37.4% of the students of the experimental groups, whereas in the controls – only 15.4%, sufficient – 42.4% and 40.4%, respectively, a decrease in the medium level – 16.9% and 36, respectively, and the initial level, respectively, – 3.3% and 8.2%. These indicators show that students are aware of their own involvement in solving environmental problems and the ability to make environmental-friendly decisions.

According to the practical criterion, a high level was reached by 36.4% of students of experimental groups, 15.2% – in the control groups, 42.3% and 39.8%, respectively, – sufficient, 17.8% and 36.4%, respectively, – beginner, and 3.5% and 8.6% reached the beginner level. The revealed positive changes testify to the mastery of general professional and specialized skills of interaction with the environment.

Evaluation of experimental data allowed us to detect not only the high efficiency of the proposed technology for the formation of an environmental culture of the chemical faculty students but also to trace the positive dynamics of the quality indicators growth.

According to the data obtained, the increase in indicators of a high level of ecological culture formation among students of experimental groups according to the motivational criterion was 23% and only 0.9% among the control groups; a sufficient level – respectively 7.3% and 3.1%; by axiological criterion, this increase was at a high level of 21.8% (2.0%), sufficient – 10.1% (2.2%); according to the cognitive criterion, respectively, at a high level – 24.8% (1.2%); according to the reflexive criterion, this increase was at a high level of 23.3% (1.5%); according to practical criteria, respectively, at a high level – 22.1% (0.7%).

Results analysis of a series of sections of the formative experiment stage have shown a decrease in the number of students who had an initial level of ecological culture according to the above-given criteria, respectively, an increase in students of experimental groups was – 6.9%, – 5.9%, – 5.2%, – 6, 2%, – 6.4%; in the control groups – 1.2%, – 0.9%, – 1.0%, – 1.1%, – 1.1%.

In both compared categories, there was a decrease in the number of students with a medium level of ecological culture, but this tendency is more pronounced in experimental groups. Consequently, a decrease in the proportion of students who had initial and medium levels of ecological culture led to an

increase in the number of students with sufficient and high levels. These indicators are more clearly expressed in the experimental groups. The dynamics of the formation levels of the ecological culture of chemical faculty students in control (CG) and experimental (EG) groups are reflected in Figures 5 and 6.

After finishing the pedagogical experiment, the methods of mathematical processing of numerical data using the Kolmogorov-Smirnov λ -criterion have been used, and a point has been found where the sum of the discrepancies between the empirical distributions in the EG and CG is the greatest, and the significance of differences is evaluated (Tables 6-10).

Let us formulate the null hypothesis (H_0) about the normal distribution: the empirical distributions of the levels of formation of motivational, axiological, cognitive, reflexive and practical criteria of the ecological culture of the CG and the EG do not differ. H_1 : the empirical distributions of the levels of formation of the motivational, axiological, cognitive, reflective and practical criteria of the ecological culture of the CG and the EG are different.

The critical value is taken as follows: $\lambda_{0.05} = 1.36$. According to the λ -criterion, since $2.34 > 1.36$, the discrepancies between the empirical distributions in the EG and CG are certain (Equation 4). Therefore, the hypothesis H_1 is accepted.

The critical value is taken as follows: $\lambda_{0.05} = 1.36$. According to the λ -criterion, since $2.46 > 1.36$, the discrepancies between the empirical distributions in the EG and CG are certain (Equation 5). Therefore, the hypothesis H_1 is accepted.

The critical value is taken as follows: $\lambda_{0.05} = 1.36$. According to the λ -criterion, since $2.40 > 1.36$, the discrepancies between the empirical distributions in the EG and CG are certain (Equation 6). Therefore, the hypothesis H_1 is accepted.

The critical value is taken as follows: $\lambda_{0.05} = 1.36$. According to the λ -criterion, since $2.13 > 1.36$, the discrepancies between the empirical distributions in the EG and CG are certain (Equation 7). Therefore, the hypothesis H_1 is accepted.

The critical value is taken as follows: $\lambda_{0.05} = 1.36$. According to the λ -criterion, since $2.10 > 1.36$, the discrepancies between the empirical distributions in the EG and CG are certain (Equation 8). Therefore, the hypothesis

H_1 is accepted. The calculations made show that the critical values of $\lambda_{0.10} \approx 1.23$ and $\lambda_{0.05} \approx 1.36$ are significantly less than the actual (empirical) values. Therefore, the null hypothesis is rejected, which means that the CG and the EG are not homogeneous.

Currently, there is no single method for assessing sustainable development and the impact of education on the social environment and its development is an urgent problem in the scientific environment. For this purpose, an indicative system for assessing the level of the ecologization of territory due to the ecologization of education is proposed. The method of aggregation based on four groups of indicators (ecological, economic, social, international and innovative) was applied when constructing. The set of indicators includes sub-indicators, integral indicators and an aggregative indicator of the highest order to assess the level of ecologization of the territory due to the ecologization of education. A distinctive feature of the proposed system is the inclusion of the indicators characterising not only the three traditional spheres of impact on the environment - economic, ecological and social but also the indicators characterising the sphere of international and innovative activity. A comprehensive assessment allows to identify shortcomings in the ecologization of the territory due to the ecologization of education and take them into account in the operative order when adjusting the programmes of its development.

The initial set of subindicators is formed from indicators used in different international assessment methodologies of sustainable development (United Nations Commission on Sustainable Development, OECD and World Bank) and integral indicators (EDP, HDI, ESI, LPI, EF GPI, ISEW) grouped by the main directions of assessment of the ecologization level of the territory due to ecologization of education and types of economic activity (Table 11).

For expert assessment, it was proposed an ordinal scale from "0" to "5" points which allows to order the considered sub indicators and reveal hidden ordering with the help of experts. The result of the assessment is the formation of a basic set of sub indicators to assess the level of ecologization of the territory due to the ecologization of education in five main directions. According to the author, the formation of an additional set of sub indicators is advisable to carry out by the method of expert selection, taking into account the dependence between the

sub indicators (Table 12) based on constructing matrix dependence.

The most significant will be the sub indicators which gained the highest point in ranking by the independence degree and compliance with the objectives of the territorial programme of ecologization (Table 13).

For the effective application of the proposed system of indicators to assess the level of ecologization of the territory due to the ecologization of education, it is necessary to determine the threshold values that indicate the output of controlled sub indicators beyond the permissible range (Table 14). It should be taken into account that the changes of the values of sub indicators have different gradation depending on the direction of change – positive or negative. The transition of the sub indicator from one range to another reflects the effectiveness of decisions taken at the territorial level in the field of ecologization.

Direction of sub indicator value changes:

A – permissible range of sub indicator values;

B – range of values which characterise a small deviation of sub indicator within the variable norm;

C – range of values which characterise a deviation of sub indicator within the threat to ecologization;

D – range of values which characterise a deviation of sub indicator in the direction of deecologisation.

The use of the indicative system of indicators for assessing the level of ecologization of territory due to the ecologization of education with clearly identified ranges of permissible and critical values will allow the regional authorities to exercise control in the operative order and model the scenarios of development of the processes of ecologization of the territory due to ecologization of education including a movable external environment.

For the effective implementation of the indicative system for assessing the level of ecologization of the territory due to the ecologization of education proposed by the author, a sequence of actions for its implementation is proposed. The calculation of the aggregated indicator to assess the level of ecologization of the territory due to the ecologization of education is carried out by the formula (Equation 9). Where L_{ge} – aggregative

indicator of the level of ecologization of the territory due to the ecologization of education; L_{ec} – integral economic indicator; L_{ecg} – integral ecological indicator; L_{im} – integral indicator of international and innovative activities; L_s – integral social indicator.

For practical use of the aggregated indicator of the highest order, it was developed a criterion assessment systematising the values of the levels of ecologization of areas due to the ecologization of education (Table 15).

5. CONCLUSION:

The dynamics of the values of the highest aggregative indicator, that is, ecologization level allows to determine the trajectory of sustainable development of the territory, identify the need to create interrelated programmes of territorial development in the field of ecologization. Besides, the aggregative indicator provides an opportunity to measure and monitor the level of ecologization of the territory due to the ecologization of education. The use of the proposed approach will allow the regional authorities to exercise operative control and model the scenarios for the development of the processes of ecologization of the territory due to the ecologization of education, taking into account the external environment changes.

Consequently, the effectiveness of the technology of forming ecological culture among the chemical faculty students in the process of vocational training has been proved with the methods of mathematical statistics. The results of the control sections of the experiment's developmental phase have confirmed the effectiveness of the proposed learning technology. In the course of the study, we have also determined the levels of formation of ecological culture indicators according to motivational, axiological, cognitive, reflexive and practical criteria. Positive changes have been revealed among the students of experimental groups, which confirms the effectiveness of the experimental technology influence and testifies to the effectiveness of the chosen pedagogical conditions, which ensured the viability of the model, in particular, the targeted design of an information-ecological educational environment; ensuring positive motivation of students of the chemical faculty to the formation of ecological culture; education of the need for continuous professional self-improvement among students of the chemical faculty; attracting students of the Chemistry Faculty to environmental activities, which has led to an increase in the levels of

ecological culture.

6. REFERENCES:

1. Adler, I., Zion, M., Mevarech, Z.R. *Journal of Research in Science Teaching*, **2016**, 53(4), 620-663.
2. Akhmetshin, E.M., Mueller, J.E., Yumashev, A.V., Kozachek, A.V., Prihodko, A.N., Safonova, E.E. *Journal of Entrepreneurship Education*, **2019a**, 22(1), 1-12.
3. Akhmetshin, E.M., Pavlyuk, A.V., Ling, V. V., Mikhailova, M.V., Shichiyakh, R.A., Kozachek, A.V. *Journal of Entrepreneurship Education*, **2019b**, 22, 1-12.
4. Aleksandrova, O., Hroznyi, I., Vinnikova, N., Chuvasova, N. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, **2019**, 2019(2), 153-162.
5. Aliyeva, A., Dlimbetova, G., Bakirova, K., Shaimerdenova, G. *Springer Proceedings in Complexity*, **2016**, 347-352.
6. Anderson, D. *Vocations and Learning*, **2008**, 1(2), 105-29.
7. Brown, M. *Research in Science Education*, **1992**, 22(1), 63-71.
8. Cherdymova, E.I., Afanasjeva, S.A., Parkhomenko, A.G., Ponyavina, M.B., Yulova, E.S., Nesmeianova, I.A., Skutelnik, O.A. *EurAsian Journal of BioSciences*, **2018**, 12(2), 167-174.
9. Fateev, V.N., Fateeva, I. *Anthropologist*, **2016**, 23(1-2), 148-151.
10. Flagg, J.A., Bates, D.C. *International Journal of Sustainability in Higher Education*, **2016**, 17(4), 489-505.
11. Genc, M., Genc, T., Rasgele, P.G. *International Research in Geographical and Environmental Education*, **2018**, 27(4), 326-340.
12. Generalov, M. B. *Chemical and Petroleum Engineering*, **1998**, 34(9), 611-19.
13. Gevorgyan, S., Adanallyan, A. A Comparison Of Ecological Education And Sustainable Development Education in Allen-Gil, S., Stelljes, L., Borysova, O. (Eds.): *Addressing Global Environmental Security Through Innovative Educational Curricula* (57-61), Dordrecht: Springer Netherlands, **2009**.
14. Gough, A. *Cultural Studies of Science Education*, **2017**, 12(4), 889-905.
15. Grishaeva, Y.M., Tkacheva, Z.N., Medvedkov, A.A., Volgin, A.V., Krylov, P.M., Litvinenko, V.V. *Man in India*, **2017**, 97(14), 1-9.
16. Grodzinska-Jurczak, M. *Environmental Science and Pollution Research*, **2000**, 7(4), 235-38.
17. Harding, K.L., Aguayo, V.M., Masters, W.A., Webb, P. *BMC Public Health*, **2018**, 18(1), 470.
18. Isakova, A. *Materials of the 18th International Multidisciplinary Scientific Geoconference: "International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management"*. Albena, Bulgaria, **2018**, 115-122.
19. Kaigorodova, G.N., Kosarenko, N.N., Shapovalov, D.A., Sayfutdinova, G.B., Sharonov, I.A., Ignatov, S.B., Kartushina, I.G. *Eurasian Journal of Analytical Chemistry*, **2017**, 12(7), 1079-1088.
20. Kim, E.-J.A., Asghar, A., Jordan, S. *Canadian Journal of Science, Mathematics and Technology Education*, **2017**, 17(4), 258-70.
21. Kimmerer, R.W. *Journal of Environmental Studies and Sciences*, **2012**, 2(4), 317-23.
22. Lee, S.-O. *Asia Pacific Education Review*, **2007**, 8(2), 194-204.
23. Lee, S.-S., Hung, D., Teh, L. W. *Educational Research for Policy and Practice*, **2016**, 15(1), 55-70.
24. Liu, Z., Chai, Y.J. A Multimedia Based Natural Forest Park for Ecological Education in Xie, A., Huang, X. (Eds.): *Advances in Computer Science and Education* (397-402), Heidelberg: Springer Berlin Heidelberg, **2012**.
25. Lopes, A., Boyd, P., Andrew, N., Pereira, F. *Higher Education*, **2014**, 68(2), 167-83.
26. Lowan-Trudeau, G. *Cultural Studies of Science Education*, **2017**, 12(1), 119-28.
27. Marekha, I., Omelyanenko, V. *Economic Annals-XXI*, **2017**, 162(11-12), 9-12.
28. Maslennikov, V., Grishina, O., Lyandau,

- Y., Kalinina, I. *Proceedings of the 30th International Business Information Management Association Conference, IBIMA 2017 – Vision 2020: “Sustainable Economic development, Innovation Management, and Global Growth”*. Madrid, Spain, **2017**.
29. Manzheley, I.V. *Teoriya i Praktika Fizicheskoy Kultury*, **2016**, 2016-January(12), 38-40.
 30. Mueller, M.P. *Science & Education*, **2009**, 18(8), 1031–56.
 31. Pechancová, V., Hrbáčková, L., Dvorský, J., Chromjaková, F., Stojanovic, A. *Entrepreneurship and Sustainability Issues*, **2019**, 7(2), 825–41. [http://doi.org/10.9770/jesi.2019.7.2\(3\)](http://doi.org/10.9770/jesi.2019.7.2(3)).
 32. Pryor, A., Carpenter, C., Townsend, M. *Journal of Outdoor and Environmental Education*, **2005**, 9(1), 3–13.
 33. Richardson, G.B., Castellano, M.E., Stone, J.R., Sanning, B.K. *Evolutionary Psychological Science*, **2016**, 2(1), 58–69.
 34. Rusko, M., Lumnitzer, E. *Proceedings of the 15th IEEE International Conference on Emerging eLearning Technologies and Applications*. Sary Smokovec, Slovakia, **2017**.
 35. Sagiyeva, R., Zhuparova, A., Ruzanov, R., Doszhan, R., Askerov, A. *Entrepreneurship and Sustainability Issues*, 6(2): 711–28. [http://doi.org/10.9770/jesi.2018.6.2\(17\)](http://doi.org/10.9770/jesi.2018.6.2(17)).
 36. Sasongko, G., Huruta, A.D., Pirzada, K. *Entrepreneurship and Sustainability Issues*, **2019**, 7(1), 166–76. [http://doi.org/10.9770/jesi.2019.7.1\(13\)](http://doi.org/10.9770/jesi.2019.7.1(13)).
 37. V.A., Urekeshova, L. *Regional Science Inquiry*, **2017**, 9(2), 187–96.
 38. Schleicher, K. *International Review of Education*, **1975**, 21(2), 231–60.
 39. Schleicher, K. *International Review of Education*, **1989**, 35(3), 257–81.
 39. Sofluau, R., David, D.O. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, **2018**, 36(1), 89–97.
 40. Zeleeva, V.P., Asafova, E.V. *Mathematics Education*, **2016**, 11, 4, 549-558.

$$IM = \frac{Value6+Value7}{2} \quad (\text{Eq.1})$$

$$IPM = \frac{Value1+Value2+Value5}{3} \quad (\text{Eq. 2})$$

$$ENM = \frac{Value3+Value4}{2} \quad (\text{Eq. 3})$$

$$\lambda = d_{\max} \sqrt{\frac{n_e n_k}{n_e + n_k}} = 0,264 \sqrt{\frac{152 * 163}{152 + 163}} = 2,34 \quad (\text{Eq. 4})$$

$$\lambda = d_{\max} \sqrt{\frac{n_e n_k}{n_e + n_k}} = 0,277 \sqrt{\frac{152 * 163}{152 + 163}} = 2,46 \quad (\text{Eq. 5})$$

$$\lambda = d_{\max} \sqrt{\frac{n_e n_k}{n_e + n_k}} = 0,271 \sqrt{\frac{152 * 163}{152 + 163}} = 2,40 \quad (\text{Eq. 6})$$

$$\lambda = d_{\max} \sqrt{\frac{n_e n_k}{n_e + n_k}} = 0,24 \sqrt{\frac{152 * 163}{152 + 163}} = 2,13 \quad (\text{Eq. 7})$$

$$\lambda = d_{\max} \sqrt{\frac{n_e n_k}{n_e + n_k}} = 0,237 \sqrt{\frac{152 * 163}{152 + 163}} = 2,1 \quad (\text{Eq. 8})$$

$$Lge = \frac{Lec + Lecg + Lim + Ls}{4} \quad (\text{Eq. 9})$$

Table 1. The distribution of motives to make a choice of the profession for the students of the chemical faculty of experimental groups

Value	Motives	EG
1	Pursuance of the nature conservation	0.82
2	Desire to participate in environmental activities	0.76
3	The desire for self-realization, namely in the sphere of ecology	0.72
4	The desire to be competitive in the labor market	0.51
5	The desire to be spiritually rich as well as cultural and beneficial to society	0.44
6	Desire to reach social prestige	0.41
7	It is unmodern to be uneducated	0.3

Table 2. Motivational complex for the choice of profession by the students of experimental groups

IM	IPM	ENM
4.02	2.73	2.08

Table 3. Indicators' dynamics of the formation of value orientations among students of experimental and control groups+

Value Orientations	EG before the experiment	EG after the experiment	CG before the experiment	CG after the experiment
Realizing that not only a person but also every kind of animal and plant has the right to exist as a result of a long evolution	0.69	0.89	0.68	0.82
Realizing that every intrusion into nature can lead to positive as well as negative circumstances for people's health	0.74	0.88	0.7	0.84
Realizing oneself being a part of nature	0.73	0.87	0.67	0.83
Development of the cognitive interest to solving the ecological issues	0.74	0.89	0.69	0.85
Ability to observe nature	0.72	0.89	0.71	0.8
Improving one's own inner world through realizing the sense of personal indifference, dignity, carefulness and mutual help	0.71	0.88	0.7	0.78
Realizing one's uniqueness and singularity of nature	0.79	0.9	0.72	0.82
Development of the aesthetic feeling of nature, desire to see, create and learn the beautiful	0.71	0.86	0.7	0.83
Desire to preserve the flora and fauna	0.73	0.9	0.73	0.84
Desire to increase the wealth of nature	0.7	0.88	0.68	0.85
Realizing the fact that ecological situation threatens the needs and interests of a person	0.76	0.9	0.73	0.83
Studying the reasons of ecological crisis, ways of its avoiding for the benefit of a person as well as nature	0.72	0.88	0.67	0.77

Using scientific-technological achievements of the STR in the professional activities	0.69	0.84	0.69	0.76
Desire to preserve nature as an element of cultural environment	0.75	0.9	0.73	0.83

Table 4. The level of formation of professional knowledge among students of experimental and control groups

Knowledge	EG before the experiment	EG after the experiment	CG before the experiment	CG after the experiment
Levels of biological life organisation	0.71	0.89	0.66	0.81
Theories of the origin and evolution of life on Earth	0.73	0.91	0.64	0.79
Biological diversity of the organisms at species, cenotic and ecosystem level	0.76	0.9	0.69	0.78
Main terms and laws of ecology	0.77	0.91	0.68	0.8
Dependence of the organism on the area of inhabitation on different stages of the life circle	0.75	0.89	0.61	0.75
Structure, components, biosphere dynamics	0.78	0.88	0.7	0.82
Populations, ecosystems, biocenoses	0.76	0.9	0.73	0.83
Composition and structure of the Earth and the earth's crust	0.74	0.88	0.72	0.84
Geomorphological landscapes	0.71	0.89	0.7	0.8
Biochemical cycles of substances in the biosphere	0.71	0.9	0.69	0.78
Patterns of formation of natural resources, their distribution	0.7	0.9	0.72	0.81
Sources of pollution and development of measures to improve the state of the environment	0.74	0.91	0.73	0.77
Person's influence on nature, ecological crisis	0.76	0.89	0.75	0.82
Global ecological problems, disasters, ways to overcome them	0.72	0.9	0.69	0.76
Definiton and prediction of environmental risk	0.71	0.88	0.72	0.8
Relationship of pollution of regions with the state of vegetation and human health	0.72	0.9	0.7	0.79
Protection of flora and fauna	0.74	0.92	0.73	0.81
Methods of measuring environmental parameters, devices and their principles of work	0.75	0.88	0.74	0.79
Nature Reserve Fund	0.72	0.89	0.69	0.81
Objects and subjects of environmental monitoring	0.64	0.88	0.66	0.78
Types of environmental monitoring	0.67	0.9	0.69	0.76
Monitoring of the atmosphere, hydrosphere, lithosphere, biological	0.67	0.9	0.68	0.78

resources				
Methods of physical and chemical analysis	0.66	0.9	0.7	0.79
Landscapes	0.69	0.9	0.68	0.8
Environmental safety standards for air, water usage, soil, radiation safety of environmental components (MPC, MPD)	0.68	0.9	0.66	0.79
Air, soil, water protection	0.76	0.86	0.7	0.78
Types, ways, scales of natural resources usage; depletion, restoration and replacement of natural resources	0.73	0.89	0.71	0.82
Concept of environmental protection activity	0.76	0.89	0.72	0.83
Economic approaches to the protection of the environment	0.75	0.86	0.73	0.79
Regulatory framework, government regulation and management in the field of environmental examination	0.74	0.89	0.75	0.8
Types of ecological examination	0.73	0.9	0.71	0.77

Table 5. Formation of the ecological culture of the chemical faculty students (the formative stage of the experiment)

Criteria	Motivational		Axiological		Cognitive		Reflexive		Practical	
	EG	CG	EG	CG	EG	CG	EG	CG	EG	CG
Levels	%	%	%	%	%	%	%	%	%	%
High	36.2	14.3	35.6	15.6	38.2	14.5	37.4	15.4	36.4	15.2
Sufficient	44.6	40.1	46.5	38.8	43.6	40.2	42.4	40.4	42.3	39.8
Medium	16	36.9	14.5	37.3	14.1	37.1	16.9	36	17.8	36.4
Beginner	3.2	8.7	3.4	8.3	4.1	8.2	3.3	8.2	3.5	8.6

Table 6. Calculation of the λ -criterion for comparing empirical distributions in the EG and CG of the indicators of the motivational criterion formation (the formative stage of the experiment)

Levels	Empirical frequency		Empirical relative frequency		Cumulative empirical relative frequency		Discrepancies $d = \sum f^*e - \sum f^*k$
	fe	fk	f*e	f*k	$\sum f^*e$	$\sum f^*k$	
High	55	23	0.362	0.143	0.362	0.143	0.219
Sufficient	68	65	0.446	0.401	0.808	0.544	0.264
Medium	24	60	0.16	0.369	0.968	0.913	0.055
Beginner	5	14	0.032	0.087	1	1	
Total	152	163	1	1			

Table 7. Calculation of the λ -criterion for comparing the empirical distributions in the EG and CG of the formation of axiological criterion indicators (the formative stage of the experiment)

Levels	Empirical frequency		Empirical relative frequency		Cumulative empirical relative frequency		Discrepancies $d = \sum f^*e - \sum f^*k$
	fe	fk	f*e	f*k	$\sum f^*e$	$\sum f^*k$	
High	54	25	0.356	0.156	0.356	0.156	0.2
Sufficient	71	63	0.465	0.388	0.821	0.544	0.277
Medium	22	61	0.145	0.373	0.966	0.917	0.049
Beginner	5	14	0.034	0.083	1	1	
Total	152	163	1	1			

Table 8. Calculation of the λ -criterion for comparing the empirical distributions in the EG and CG of the formation of cognitive criterion indicators (the formative stage of the experiment)

Levels	Empirical frequency		Empirical relative frequency		Cumulative empirical relative frequency		Discrepancies $d = \sum f^*e - \sum f^*k$
	fe	fk	f*e	f*k	$\sum f^*e$	$\sum f^*k$	
High	58	24	0.382	0.145	0.382	0.145	0.237
Sufficient	66	66	0.436	0.402	0.818	0.547	0.271
Medium	21	60	0.141	0.371	0.959	0.918	0.041
Beginner	6	13	0.041	0.082	1	1	
Total	152	163	1	1			

Table 9. Calculation of the λ -criterion for comparing the empirical distributions in the EG and CG of the formation of reflexive criterion indicators (the formative stage of the experiment)

Levels	Empirical frequency		Empirical relative frequency		Cumulative empirical relative frequency		Discrepancies $d = \sum f^*e - \sum f^*k$
	fe	fk	f*e	f*k	$\sum f^*e$	$\sum f^*k$	
High	57	25	0.374	0.154	0.374	0.154	0.22
Sufficient	64	66	0.424	0.404	0.798	0.558	0.24
Medium	26	59	0.169	0.36	0.967	0.918	0.049
Beginner	5	13	0.033	0.082	1	1	
Total	152	163	1	1			

Table 10. Calculation of the λ -criterion for comparing the empirical distributions in the EG and CG of the formation of practical criterion indicators (the formative stage of the experiment)

Levels	Empirical frequency		Empirical relative frequency		Cumulative empirical relative frequency		Discrepancies $d = \sum f^*e - \sum f^*k$
	fe	fk	f*e	f*k	$\sum f^*e$	$\sum f^*k$	
High	55	25	0.364	0.152	0.364	0.152	0.212
Sufficient	64	65	0.423	0.398	0.787	0.55	0.237
Medium	27	59	0.178	0.364	0.965	0.914	0.051
Beginner	5	14	0.035	0.086	1	1	
Total	152	163	1	1			

Table 11. Group of indicators in the directions of ecologisation and economic activities to assess the ecologisation level of the territory due to the ecologisation of education

Considered calculation method	Main identified advantages	Main identified disadvantages	Adjusted set of indicators based on the results of expert assessment	Indicators proposed by the author
United Nations Commission on Sustainable Development	Indicators used in the methodology are divided into 4 groups: social, economic, ecological (with subgroups: water resources, land resources, other natural resources, atmosphere and waste) and	Indicators used do not have a strongly pronounced specificity and can be simultaneously attributed to the other directions of ecologisation	GRP per capita; Percentage of GRP allocated on environmental protection; Environmental taxes and subsidies; Amount of additional financing for sustainable development after	Share of environmental entrepreneurship in the territory Share of the population of the territory engaged in the ecological sector Ecological costs index Ecology economisation index

<p>organisational. Three types of indicators indicate "Driving force indicators", "Current state Indicators" and "Response Indicators". The set of indicators in the group corresponds to the following sections:</p> <p>"Agenda for the 21st century": economic development, change of consumption pattern, financial resources and mechanisms. Among the indicators used there are 5 indicators that directly characterise the process of ecologisation (No. 45, 63 – 66) in the economic direction</p>	<p>1992; Adjusted net national income per capita; National product per capita adjusted for ecological damage</p>
---	--

Table 12. Dependences of subindicators of assessing the ecologisation level of territory due to the ecologisation of education

Name of subindicator group	Conventional name	Dependency characteristics	Dependency description	Expert importance, points
Indicators-substitutes	IS	Change of one subindicator in a pair directly affects the value of the second indicator	Directly proportional	1
Complementary subindicators	CS	Increase of one of the su-indicators in a pair leads to the decrease of the second one	Inversely proportional	2
Independent subindicators	InS	Both subindicators are independent	No dependency	3

Table 13. Dependency matrix of sub-indicators to assess the ecologisation level

Name of arbitrary subindicator	Ordinal number of indicator	1	2	3	4	5	Final assessment of the dependence of subindicators, points
Coefficient of environmental friendliness of production	1		CS = 2	InS = 3			5
Coefficient of environmentally friendly production	2	CS = 2		IS = 1			3
Development index of ecological branding	3	InS = 3	IS = 1	-			4

Table 14. Range of values of subindicators (fragment)

Name of subindicator	Name of the integral indicator on the selected topic Ecological indicator – I_{ecg} Range of values of the integral indicator, %						
	D	C	B	A	B	C	D
Coefficient of environmental friendliness of production	< 0	0–10	10–20	20–33	34–45	46–50	> 51
Coefficient of environmentally friendly production	< 0	0–10	10–20	20–33	34–45	46–50	> 51
Development index of ecological branding	< 0	0–10	10–20	20–33	34–45	46–50	> 51

Table 15. Value gradation of the aggregative indicator of ecologisation of territory due to the ecologisation of education

Level's name	0 level "Zero"	1 level "Elementary"	2 level "Basic"	3 level "Medium"	4 level "High"	5 level "Advanced"
Degree characteristics	absence of ecologisation process in all spheres of activity	developments in the direction of the implementation of the process of ecologisation of the territory due to the ecologisation of education	presence of the most common and necessary spheres of ecologisation of the territory due to the ecologisation of education for development	development of ecologisation of the territory	active process of integration of economy and ecology	assessment of the real development of ecologisation of the territory due to the ecologisation of education as a process
Value of integral indicators						
Economic indicator	[0–0.05]	[0.051–0.08]	[0.081–0.1]	[0.11–0.2]	[0.21–0.3]	[0.31–0.4]
Ecological indicator	[0–0.05]	[0.051–0.08]	[0.081–0.1]	[0.11–0.2]	[0.21–0.3]	[0.31–0.4]
Indicator of international and innovative activities	[0–0.05]	[0.051–0.08]	[0.081–0.1]	[0.11–0.2]	[0.21–0.3]	[0.31–0.4]
Social indicator	[0–0.05]	[0.051–0.08]	[0.081–0.1]	[0.11–0.2]	[0.21–0.3]	[0.31–0.4]
Aggregative indicator of the ecologisation level of the territory due to the ecologisation of education	[0–0.05]	[0.051–0.08]	[0.081–0.1]	[0.11–0.2]	[0.21–0.3]	[0.31–0.4]

Figure 1. Motivation dynamics

Figure 2. The level of development of professional environmental knowledge (experimental groups)

Figure 3. Dynamics of the level of professional skills development necessary for the formation of an ecological culture (experimental groups)

Figure 4. Types of self-awareness of environmental activities (experimental groups)

Figure 5. Level dynamics of the ecological culture formation among the future students of the chemical faculty (control groups)

Figure 6. Level dynamics of the ecological culture formation among the future students of the chemical faculty (experimental groups)