

## EDUCATIONAL TECHNOLOGIES OF ECOLOGICAL EDUCATION WITHIN THE PROCESS OF NATURAL SCIENCES STUDY.

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While working at theoretical concept of ecologic education research we came to the necessary decision to work out pedagogical technologies and techniques to provide educational process with ecologic content in the forms of curriculum and extracurricular lessons as purely educational processes.

In order to research and work out effective pedagogical technologies we have stood on the education project's theoretical statements suggested by B.D. Elkonin, S.D. Maksimenko, Y.I. Mashbits, M.L. Smulson, L.I. Fomichova. Upon the researchers' statements mentioned above education project is generally new one with significant processes and separate constitutes. Taking it into consideration we should think of modern natural science study as systematic-logical and personal-oriented. Modern scientific research allow to assess the study as part of education project which is closely connected with other project's parts and assists to decide total project cycle tasks.[10]

The present pedagogical research goal is development of effective ecologic education technologies within the process of natural sciences study.

Education process demands to pay great attention to its complexity and flexibility of its approach. The process' relativity and unity can be discussed just in general. Taking into consideration relatively clear goals and great changeability of the tasks the study can be realized differently. The effectiveness of our developed ecologic education concept is assessed by technologies and techniques. Effective education approach analysis is the important question because techniques and technologies are defined by basic constitutes of education process and they are comprised into larger pedagogical tasks and approaches. The major of them are: information provision in normative frames; motivation approach; practical realization of information.[2]

Coming from given traditions the lesson is defined as significant pedagogical project task of ecologic education. The process' consistency is variable considerably and that is why it is influential on possible process modifications. They can vary primarily in details, for example, unusual new material teaching methods, significant decisions or tasks correlation. During the experiment the effectiveness of the approach of outer-directed, self-oriented and comprehensive study of ecologic material problematic tasks solving by the students has been proved. Such approach encourages cognitive process of practical and scientific tasks solving by students. This approach of pedagogical technology creates large range of ecologic material study in pedagogy and changes or influences on the activity of theoretic or practice tasks solving, check the

solutions correction. Other important changes depend on self-study level of ecologic tasks and checks organization and solution provided by students. [5]

The ecological study approaches mentioned above serve mainly for instrumental goals. Natural study includes primarily self-study of existence and its perception and understanding. The next important technological goal is study of ecological influence on activity by the students. It provides the most independent self-study. The problematic situation in pedagogic task stimulates development of cognitive features which are developed into ecological competence cognitive components in a future. Pedagogical technologies comprise environment perception and understanding goal as major part and provide self-study with further development of ecological competence. In this case education system mainly depends on eco-system type. For example, one of the ecological studies constitutes – creation of anthropogenesis (eco-system with human participation) – the next students' actions can be developed: examination and research of regional environment; eco-system study; eco-system research and analysis; human ethnic position and eco-system definition in integral ecological region; students' activity and possible practical conclusions with their own active influence. In case of environmental protection activity there is the time of total conversion and specific visualization which positively influence on emotional feelings intensity. [1]

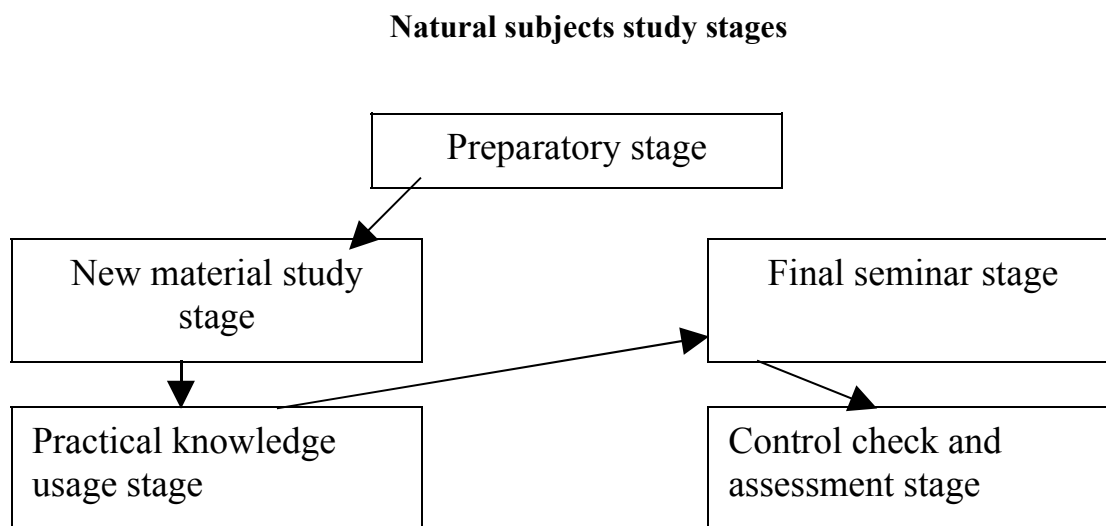
The natural study curriculum has the considerable elements of understanding cause-effect relation in ecologic system. The stated and formation experiments provided in pedagogy determine necessary existence of such elements in order to achieve stable features of ecologic competence by students. While defining and introduction of natural science study's ecologic tasks we have defined, taken into consideration and chosen ecologic content lines: environment ecology, adoption ecology, human ecology, noosphere ecology; pedagogic influence projecting possibilities to provide students with ecologic competence. The defined tasks' mutual influence has become the basis for “regulating element of cause-effect relation of natural science study” term. This term will be further shortened as “regulating element” and is meant as appearance of mechanisms of living and non-living creatures' relations in science study. These mechanisms are essential because they determine ecologic processes and situations. Regulating elements reflect real environmental processes and are based on analytical and synthetic reactions' unity in nature. The regulating elements' complexity and content study coincides with special subjects' study (biology, geography, chemistry, physics) and extends in ecologic context. Regulating element draws students' attention to the main determinative direction of possible ecologic events and consequences forecast based on found, introduced, extended and explained cause-effect relations in eco-systems of different types. Regulating element of natural science ecologic subjects' study can be introduced by variable technological approaches, verbal, symbolized, available,

demonstrational and practical usage. Selection, focus and variable argumentations of regulating elements nature create the entire environment account in system of real existing relations and influences. The regulating elements knowledge gained by student provides constant ecologic competence formation. [4, 7, 11]

During the pedagogic experiment there was research of the most effective adequate forms of study process. So lecture-practice system was used for senior school forms. Its significant feature is that each definite study stage (knowledge activation, new material introduction, skills development, check and control) limited by one natural science study program becomes independent study task with clear defined goal, its own structure and working methods. Such approach structure can be introduced as determined consistency of natural subjects study: ecologic content – ecologic skills development – ecologic knowledge and skills generalization and systematization – ecologic knowledge and skills check. [8]

The consistency given above reflects considerable key points necessary to define students study process in ecologic education. The ecological approach in pedagogic tasks' differentiation mentioned above provides content for normative, cognitive, emotional-motivational and practical components of ecologic competence. The given consistency is dynamic by its structure. According to the study material content and students' readiness a teacher has a choice of definite stage among all its modifications. According to natural subjects study material the study stages developed and experienced are presented in the scheme 1.

Scheme 1



It has been proved that study project detailed development is a complete structure of ecologically directed material of natural subjects study. The scheme 1 shows the stages order according to the ecology content transformation logic within eco-system items and their content extent based on priority consumes and strict provision of adequate pedagogical methods, ways and means of natural subjects.

The students' complete and complex preparation to percept new material provides their future self- activity productivity and accelerates study process. The structural links between already gained and planned knowledge in future are possible due to special tasks and exercises selection which are included into auxiliary part of self-study and aimed to repeat theoretical material or actions execution necessary for future themes study. Certainly, separate preparation stage has some advantages to fragmentary repetitions because it allows wide usage of ecologically directed material in natural subjects study. According to the author's interpretation this stage is featured by motivation tone because it is based on problem perspective demonstration and has purposeful and specially-oriented content. [9]

First of all we shall analyze preparatory stage. According to its structure this ecologic education stage is linked with primary systematization and generalization of initial knowledge. The difference is in prior presentation of theme and previous questions' study that are necessary for next theme study in the beginning of the stage. The availability and duration of preparatory stage is determined by the repetition volume.

The second stage of new material study should be more effectively provided in lecture with two researched approaches: academic lecture as it is defined one-component and lecture with initial knowledge check defined as two-component. The first variant involves special attention into new material introduction and explanation whereas the second variant according to the experimental data demands pedagogic tasks projecting which includes study of information usage in practice, determination of essential components of new material and structural theoretic questions' mutual links. According to ecology content (environmental ecology, human ecology, adoption ecology, noosphere ecology) the advantage should be given to two-or one-component lectures for theoretic material and its usage study.

Two-component lectures are compound form which comprises the first – theoretic – and the second – practical – parts. The study project at simultaneous employment of practical skills both theoretic and practical components can alternate and repeat many times. In case of preparatory stage absence it is also included in lecture structure.

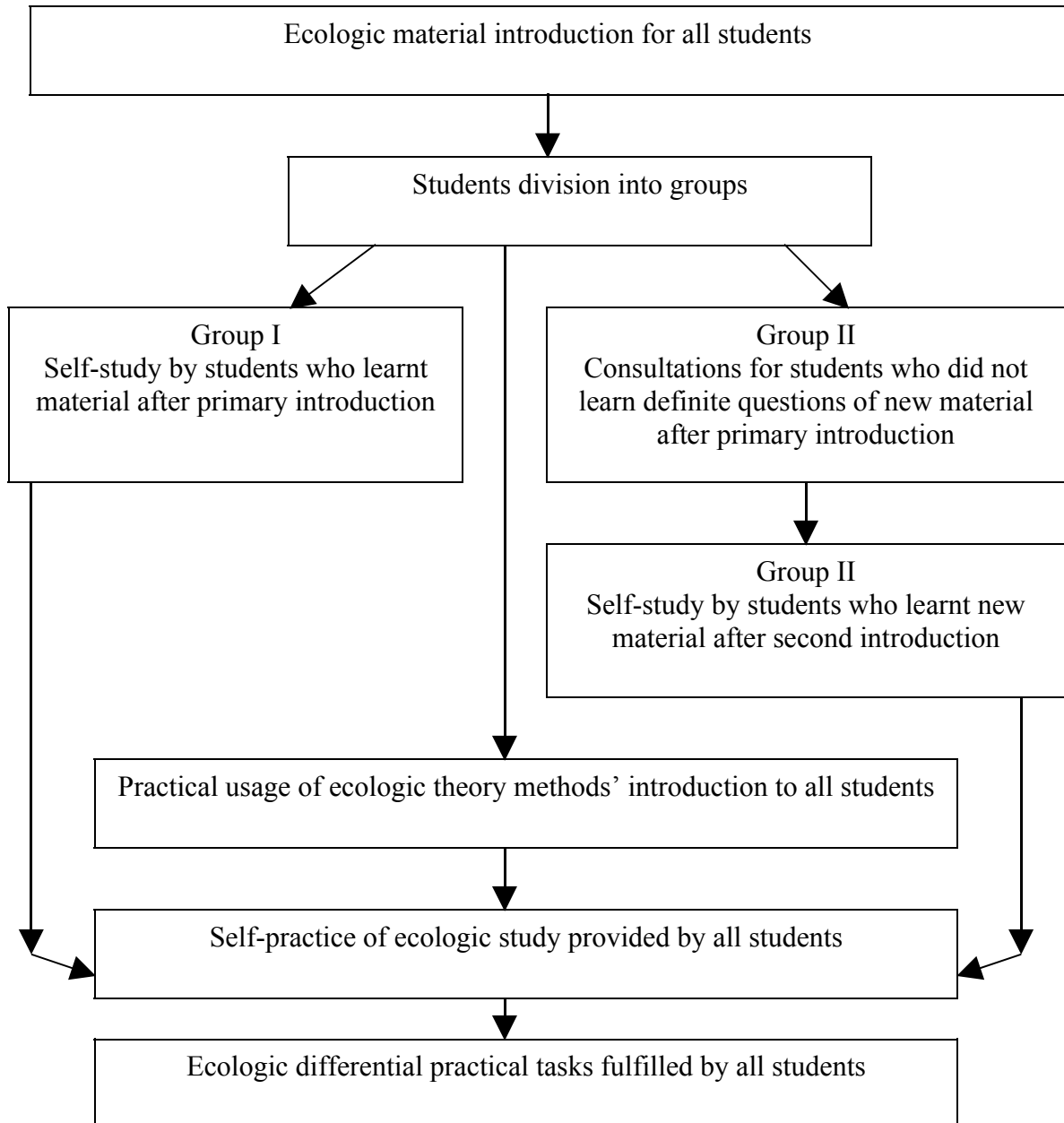
According to the experimental check explanatory lecture is addressed to students with different ecologic competence levels and it is based on staged approach to study in order to provide differential method of new ecologic material study. [6] Staged structure has been developed during the experiment. The scheme 2 presents key point of many-staged approach for study projecting which involves differentiated method of new ecologic material learning by students. Many-staged approach employs rational integration of collective, group and individual study, realization of definite pedagogic task in ecologic education and new ecologic material perception in natural subjects study by all students. The research has shown that the most

rational approach is soliloquy introduction of new material with the simplest examples of its usage which has been defined as “introduction propositions”.

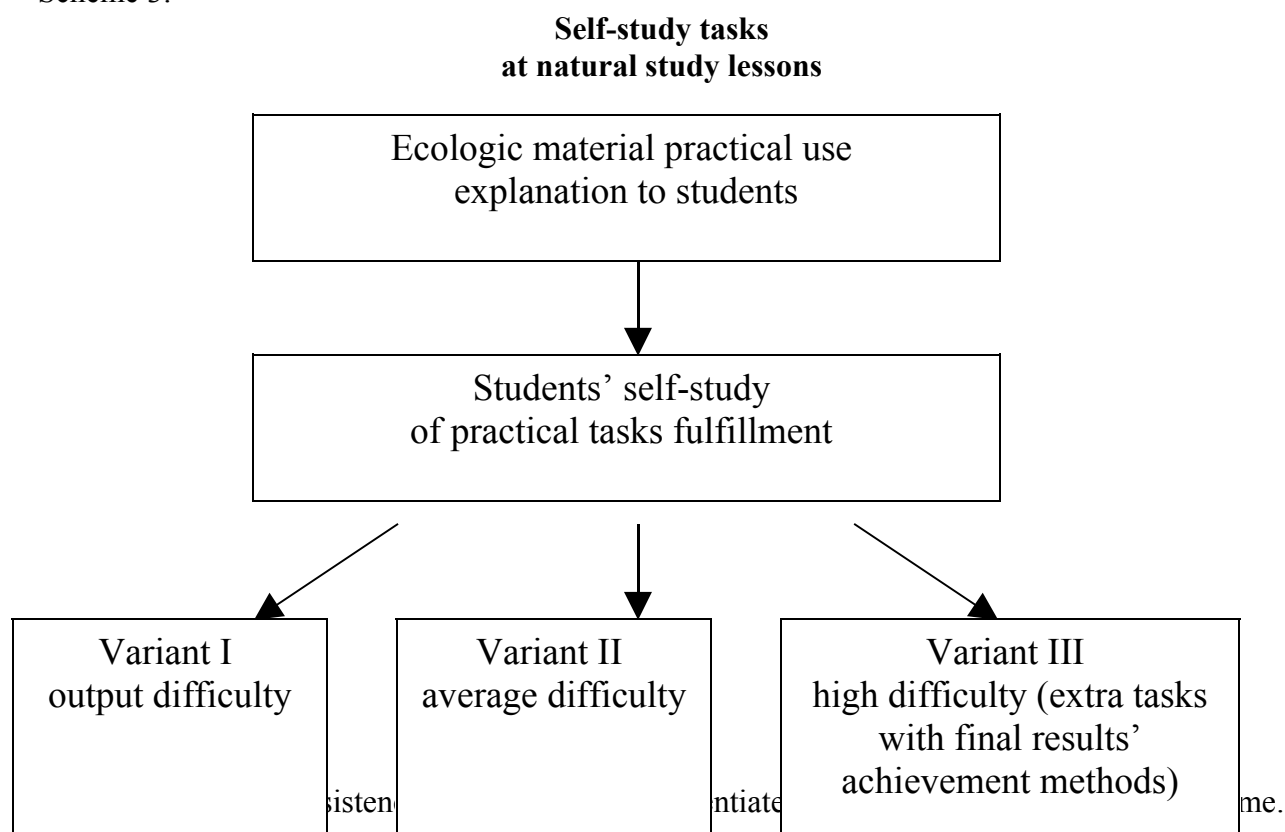
After material explanation was understood by students they started self-study work. The self-study was followed by recurring explanation in a changed form of the dialogue during which theoretic material determined as “theoretic result of common agreed actions” was corrected. Next study involved three-time explanation with teacher’s functions transition to the students’ role which was determined as “consulting”. So transition from “introduction proposition” through “theoretic result of common agreed actions” to “consulting” during lecture study process reflects procedural study of natural science subjects and many-staged approach to study project realization according to ecologic study transformation concept with eco-systems items. According to the cognitive forms and defined ecologic competence level of students’ knowledge at self-study stage the tasks were given in form of three different variants based on three different levels of their difficulty. (scheme 3)

Scheme 2.

**Staged structure of ecologic study  
by natural science subjects**



Scheme 3.



Having analyzed the proposed content of self-study works given in the scheme 3 we should mention that it is obligatory to provide them with general rules, regularities and instructions at the primary stage of ecologically aimed tasks study and fulfillment. The self-study can be preceded by general explanation of the tasks' solving types or common fulfillment of training tasks, observations, researches, expert tasks. The self-study work in the next stage for those who have solved proposed tasks. The group of students who have found the tasks difficult are organized in special group working with trainer at special tasks. As it has been shown in scheme 3 self-study is proposed to be divided into three levels of difficulty. Each student should choose appropriate level by himself. The levels differ not by quantity but by quality features and tasks demands. I variant tasks have special algorithm with defined consistency of work. III variant tasks have original or problematic features in order to explore flexibility and deepness of thinking. The tasks' choice creates such conditions that make students work with maximum efforts. The tasks' content is featured by specialty of lecture and training tasks material. The differentiated tasks' content is complicated according to the themes studied. The students working at high difficulty tasks are obliged to give comments on solution ways by the end of solving process. [3,8]

Knowledge systematization is held in the form of seminar. The form choice is conditioned by material difficulty and quantity. Seminars are final discussion upon the themes blocks. They are aimed to transform gained knowledge and definite theories into entire

knowledge system of one definite theme. Functional links of such system are formed by senior students' creative work: original approvals of ecologic statements and regulations; own rational ways to solve traditional ecologic tasks or original and non-standard ecologic situations; approval of practical importance of gained knowledge; creation logic links with previous material in the form of reports; essays; visual methods' creation (modules, schemes, drawings, tables etc.). Check and control are provided with two forms: written tests with differentiated tasks and examination. Examination is aimed to demonstrate students' study activity, knowledge gained during theme study. This stage can be variable: oral examination, frontal conversation, individual conversation, seminar, traditional questioning, home-made reports discussion with theoretic questions, written examination, oral examination with preceded preparation, theoretic-practical examination. The skills' check stage plays the great role in study results' achievement and improvement. It allows defining students' level of knowledge and detailing their skills' level. The gained information allows the researcher to solve questions of study process management, to define and correct new tasks, study content and methods, to create links between studied and new material. [10]

The main check goal is pedagogic tasks' corrections based on defined knowledge and skills by the researcher who is to provide students with high level of ecologic knowledge competence. The educational and development functions of check and control stage are to define students' skills of practical ecologic tasks' fulfillment. The pedagogical function is to develop positive and responsible attitude to ecological processes. The corrective function is to use check results to correct pedagogical tasks' goals or to develop study of entire eco-systems.

The research has proved the lecture-seminar educational form for ecologic study is the most effective. During the traditional check process students often analyze: they find cell's parts, organs, tissues, eco-system parts etc. But it is more difficult to use thinking process to make up characteristics of biological objects, processes, events; to ground scientific facts, agricultural methods, environmental protection ways, healthy life style norms, natural behavior; to compare and create cause-effect relations; to make conclusions etc. This information allows making the conclusion to pay more attention to the tasks developing analytical and systematical skills, for example, to create links between cell, organ and nature; to make conclusions about organism and entire eco-system unity, organic system indivisibility; to search causes destroying bio-sphere balance, rare animals and plants disappearance, influence on population etc. [7]

The data analysis has shown that students' knowledge level depends on their comparative ability, for example, to discover similarity and difference in variable natural beings' cells, tissues and organs structure and functions; to make conclusions in comparison of kinds, eco-systems, photosynthesis processes, breathing, energetic and plastic exchange, genotypes and photo types

of individual. Comparison tasks' usage gives the possibility to fix the skills mentioned above and to raise students' ecologic competence. It is important to remember that students often use gradual descriptions of objects and processes instead of comparison.

The study system with the stages mentioned above shows the importance of special devices (microscope, objects) practical skills' check. The special attention has been paid to develop practical skills, for example, to make researches to understand biological essential processes, to observe home plants and season changes in nature, to find out changeability and adoption skills of organisms. It allowed to strengthen natural-scientific links in ecologic education and to improve knowledge of nature study methods of natural subjects.

It is generally known that natural objects' usage improves students' understanding and remembering skills. However, not all students have time to observe objects and their parts and that is why they illustrate their reports with natural objects very rarely. So it is very important to include work with natural objects into check and control stage, it will help to find out object's structure and features, organism's genotype, structure and functions relations etc. So knowledge check and control is necessary for not just determination of basic concepts, rules, theories and scientific facts knowledge but also for different types of study formation definition. [11]

The fourth study stage has used the tasks of current, thematic and conclusion checks of ecologic competence. All types of check have been provided with different forms, methods and ways. The oral and written functions have been studied and defined. We have used oral, written (texts and graphics) and practical checks which have discovered their effectiveness and number of addresses. For example, during biology study it is more effective to use oral check which allows to gain full information about students' knowledge and to track answer logic, its completion and knowledge volume. The dialogue conversation optimizes feedback, knowledge level, skills development and corrections.

At the same time oral examination has discovered some disadvantages: firstly, it does not provide possibility to compare different students' answers to the same question; secondly, written tasks allow to check most students' answers and to pay attention to more essential questions, to strengthen knowledge due to enlarging relations and deeper analysis by elements. It has been defined that written check demands more detailed preparation and questions and answers statement aimed to systemize and generalize knowledge and its usage in new situation.

However, written tests approbation in different schools has demonstrated indirect answers of students. It has been defined that it is worth to draw attention to the dialogue with students: to involve students into other children's works analysis, corrections of ecologic questions and style of answers such as logic, laconic and structure. During natural subjects study, for example, "Plants Biology", it is necessary to use prepared answers; at photosynthesis lessons it is possible

to prepare such answer: “The photosynthesis results creation of organic substances of carbonic acid and water; organic substances are used to feed and energize animals, plants, mushrooms, most bacteria and human being; hydrogen is used to breath by all organisms.” So the formation stage of research has checked control and its approbation of number of addresses provided with worked out technologies. This has conditioned the wide usage of knowledge check based on standard and non-standard tests. The research has demonstrated the numerous advantages of testing over traditional forms and methods. For example, it provides more rational usage of time, quantitative content and quicker feedback with students, clear definition of study results, and greater attention to knowledge and skills correction work. Testing control allows to receive objective data of ecologic competence during natural subjects study. [2]

The results analysis has demonstrated that testing has some disadvantages at the same time. The choice of one correct answer allowed guessing and opportunity to cope correct answer from the next student. Testing has not give correct and clear information about students' abilities to provide researched material logically, structure and argue the answers, illustrate it with examples, creatively use theoretic knowledge to explain given eco-systems and essential consummates. It has been found out that testing makes it difficult to evaluate practical knowledge level. So the most reasonable forms and methods of check should be combined with traditional ones. For example, it is worth to combine choosing the correct answers with answers without choices and practical tasks; complex check work with open and close answers and practical tasks. It allows to define ecologic competence level objectively.

Making the conclusion in study technologies approbation we should point out the productivity of: a) directed approach to self-study of ecologic knowledge by tasks fulfillment and situations solutions; b) regulating cause-effect elements usage in natural science study; c) lecture-seminar forms involvement; d) preparatory stage, new study stage, check and control stage realization; e) many-staged feature of ecologic study in differentiated groups of self-study; f) consistency of current oral, written and practical thematic and theoretic check of ecologic competence.

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