

**ARTIGO** <https://doi.org/10.22481/praxisedu.v15i36.5889>**STRENGTHENING THE PRACTICAL COMPONENT IN THE ENVIRONMENTAL  
TRAINING OF FUTURE ENGINEERS****FORTALECIMIENTO DEL COMPONENTE PRÁCTICO EN LA CAPACITACIÓN  
AMBIENTAL DE FUTUROS INGENIEROS****FORTALECENDO O COMPONENTE PRÁTICO NO TREINAMENTO AMBIENTAL DE  
FUTUROS ENGENHEIROS**

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**Abstract:** Of the goal of study is to investigate the formation of such skills of strengthening of practical component of environmental training of students, having technical specialization. It is achieved by the introduction of such forms and methods of training, as the research of technical projects and scientific articles in the subjected area (using the method of diversionary analysis), the participation of students in the work of scientific departments at the enterprises, in eco-oriented production practice and in the interdisciplinary designing. The results of the experiment show a positive dynamics in the changes of formedness levels of the main characteristics of the students' ecological culture, and confirm the effectiveness of introduction the considered .

**Key word:** Secological training; Ecological culture; Future engineer; Meta-qualification

**Resumen:** Del objetivo del estudio es investigar la formación de tales habilidades de fortalecimiento del componente práctico de la formación ambiental de los estudiantes, que tienen especialización técnica. Se logra mediante la introducción de tales formas y métodos de capacitación, como la investigación de proyectos técnicos y artículos científicos en el área sujeta (utilizando el método de análisis de distracción), la participación de los estudiantes en el trabajo de los departamentos científicos de las empresas, en la práctica de producción

ecológica y en el diseño interdisciplinario. Los resultados del experimento muestran una dinámica positiva en los cambios de los niveles de formación de las principales características de la cultura ecológica de los estudiantes, y confirman la efectividad de la introducción de lo considerado.

**Palabra Clave:** capacitación ecológica; Cultura ecológica; Futuro ingeniero; Metacalificación

**Resumo:** Do objetivo do estudo é investigar a formação de habilidades de fortalecimento do componente prático de treinamento ambiental de estudantes, com especialização técnica. Isso é alcançado com a introdução de formas e métodos de treinamento, como a pesquisa de projetos técnicos e artigos científicos na área sujeita (usando o método de análise diversionária), a participação dos estudantes no trabalho dos departamentos científicos das empresas, na prática de produção ecológica e no design interdisciplinar. Os resultados do experimento mostram uma dinâmica positiva nas mudanças dos níveis de formação das principais características da cultura ecológica dos alunos e confirmam a eficácia da introdução do considerado.

**Palavras-chave:** Treinamento ecológico; Cultura ecológica; Futuro engenheiro; Meta-qualificação

## Introduction

The beginning of the XX century is marked by the transition of society to a new form of existence and development - the information society. This process is a natural result of scientific and technological progress and is characterized by global changes in production. It also affects the science: it becomes the main factor in the development of society, and the basic "production" of high-quality information (Zhulikova, 2010). This leads to an increase in the proportion of mental work and, accordingly, to stepping up the requirements for graduates of higher education institutions. Their qualifications, according to P. Drucker, begin to act as a "determining factor of existence or destruction" of firms (Drucker, 2004); coming to workplaces in the economy of the region, they will become the factors, ensuring its sustainable development.

However, knowledge is a special resource. The knowledge, necessary for a specialist at a given time, for solving a particular problem, can not be found in books or reported in a university. In books you can find, and in educational institutions - to master, only certain

information, but not knowledge. Knowledge is the ability of a specialist to find application of this or that information in the sphere of his activity.

In accordance with this, the requirements for the education system increase, since it is the main sphere for the reproduction of highly qualified personnel, and becomes an important factor in the country's social, economic, scientific and technological development. Therefore, now it does not need training with the communication to the future specialist of narrow professional information, and the appropriation of certain qualifications to him, but the education - formation of a specialist with a meta-qualification. Meta-qualification means a system of knowledge, allowing to acquire new knowledge, as well as the ability to find and apply new information, which is necessary at the given time, even if it goes beyond the personal experience of its carrier.

Particularly relevant is this issue, concerning the future engineers. This is explained by the fact, that the development of society is no longer possible without technical progress and transformation of the natural environment. However, the intensive development of the technosphere leads to the fact, that humanity loses control over the expanding technical reality, and the ecological situation continues to deteriorate. Therefore, the further stable and conditionally safe development of society depends on how well the activity of specialists with the technical specialization will correspond to indicators of both social and environmental acceptability; how the techniques and technologies, created by them, will be compatible with the laws of the development of biological world. In this regard, the graduates of engineering specialties of higher education institutions are imposed increased requirements, not so much on the level of their ecological and social-ecological knowledge, but on the ability to implement ecologically oriented activities at the workplace. So, in the information society, the activity of future engineers passes into the category of social values. Then, the ecological training of students of technical specialties of higher educational institutions, aimed at the formation of a specialist, who is ready to carry out his activity in designing new equipment and technologies, in accordance with modern socio-cultural and ecological norms, can be considered as the training, aimed at forming his meta-qualification.

The elements of this function of future engineer in the context of his environmental training can be considered:

- 1) an actualization of ecological culture in professional activity (Vasilieva, 2013);
- 2) the ability to predict the consequences of techniques and technologies possible impact on the ecological balance in the process of their design, to assess the degree

of this impact, and to take into account the results of the forecast and the assessment in the process of the activities' correction.

Formation of the basic skills of meta-qualification of future engineers will be promoted by the maximum stimulation of their mental and working activity in the learning process. Therefore, the purpose of the study was to find and to justify the possibilities of strengthening the practical component in the environmental training of students, having technical specialization.

The realization of this goal was planned through the strengthening of the following areas of activity of future engineers, and was expressed in the formation of the following skills:

- to carry out the mental projection of the results of own activity (for newly developed technical facilities) and to evaluate them from the standpoint of social significance and compliance with environmental laws;
- to estimate the results of professional activities (for technics and technologies, implementing and already put into operation) for the significance of their impact on the natural environment;
- to carry out ecological expertise of engineering projects.

### **Research Methods**

Experimental and research work was carried out using a set of the following methods:

- literature analysis;
- a complex of 13 authors' diagnostic methods for determining the levels of formedness of the students' ecological culture components;
- the analysis of the projects of participants in the Olympiads and students' reports on pre-degree practice;
- the experiment, aimed at modernization of the environmental training of future engineers;
- analytical and synthetic methods of processing and interpreting the results of the experiment.

## Results

The elements of the future engineer's meta-qualification can be the components of his ecological culture - education, which is regarded by the researchers as a certain type of cultural reflection, formed in the era of modernization and growth of the planet's population (Douglas, 1992; Merzon & Vinogradov, 2015; Muravieva, 2008; Özdemir et al., 2018), when the growing needs of mankind began to contradict the deterioration of the quality of natural environment.

To identify the components of the graduate's ecological culture, capable of becoming the elements of his meta-qualification, it is necessary to analyze its structure. This is also required by the pedagogical category "formation", considered as a process of conscious management by the development of a person or certain aspects of his personality, qualities, properties, and bringing them to a planned form (Savina, 2015). Thus, without the detalization of the structure of ecological culture, its formation is impossible, i.e. bringing its certain components and their characteristics to the form, "conceived" by the teacher.

The works of E.V. Muravieva approach to the establishing of structure of the future engineer ecological culture, maximally. The author considers ecological culture as a new stage in the development of universal human culture, including ecological thinking, ecological worldview, ecological awareness, jointly with common to all mankind values and ideals, humanistic ideas, methods of cognition and activity, moral and environmental norms and requirements, which together contribute to the formation of nature-conservative attitude to the world (Muravieva, 2008). This definition and the works of other researchers in the field of environmental education (Cornelissen et al., 2006; Corraliza & Berenguer, 2000

Lubell, 2002; Pooley & o'Connor, 2000; Scott & Gough, 2004; Mirzagitova & Akhmetov, 2016; Medvedev & Aldasheva, 2001; Nesgovoroda & Saveliev, 2009; Maslennikova, 2015; Asl1, & Sarikhanbeglo, 2016; Vigário et al., 2016; Kahveci et al., 2017). allowed us to structure the notion of "ecological culture" and to distinguish three components:

- 1) cognitive (the synthesis of professional and environmental knowledge, with the formation of a new, in terms of quality, eco-oriented professional knowledge);
- 2) value-orientation (moral and personal qualities, determining the readiness of the future engineer:

- to carry out mental and working activity in the conditions of insufficient information and risk in the implementing of innovative approach to solving emerging production problems;
  - be responsible for the consequences);
- 3) working (skills and activities, aimed at designing the results of engineering activities on the natural environment; assessing the environmental consequences of this activity; evaluation of the correspondence of professional activities to the conditions of sustainable development of nature and society).

Thus, all the elements of environmental culture of the future engineer can become the components of his meta-qualification.

Unfortunately, the ecological culture of many graduating engineers continues to be characterized by anthropocentrism. This is confirmed by the experiment, conducted by us during three years (2009, 2012, 2015), with the participation of 2153 students, having engineering and technical specializations (Kazan National Research Technical University named after A.N. Tupolev, Naberezhnye Chelny Institute of the Kazan Federal University, Kazan State Energy University, Udmurt State Technical University).

Briefly, the results of the research can be presented as follows:

- 72% of students are not ready to show either personal or collective activity in the prevention of environmental disasters;
- 53% of respondents do not have confidence in the possibility of personal resolution of environmental problems;
- 71% of future engineers are ready in their work to ignore the facts of negative impact on nature;
- 68% of students have a passive-consumer attitude towards nature and its resources;
- 77.4% of respondents have never done anything to solve environmental problems.

Among the models of possible behavior, 98% of them see their participation in the urban improvement works.

Annual participation in the work of commission of the All-Russian Ecological Student Olympiad (2008-2016) allows us to state, that the abilities of future engineers to design their research activities, to assess the impact of machinery and technologies on the nature before and after implementing environmentally-oriented measures, are insufficient. In 2012 the commission was forced to exclude the statement of hypothesis from the requirements to the projects, in view of the complexity of its development by the contestants.

Only 62.5% of the projects contained an effectively developed methodological base for the study; 64.5% of the projects had formally stated, obviously impossible goals and tasks. This was explained by the inability of executors to model their activities mentally and to predict the results.

These characteristics do not correspond to the meta-qualification of the future engineer with the focus on natural and professional activities.

As a partial solution of this problem we see in the strengthening of the practical component of environmental training of students.

The change in the form and content of this process was carried out in the following directions:

1. Inclusion in the content of practical training of analytical work on the research:
  - scientific journal articles in the field of environmental safety. The goal is to identify and to analyze in detail the factors, triggering the accidents with environmental consequences, the search for possible ways to prevent them;
  - real technical or technological projects. The purpose is to assess their environmental friendliness (performing the environmental expertise).
2. Introduction to the practice of training the method of diversionary analysis, which makes it possible to predict undesirable phenomena, on the basis of identifying weaknesses in the analyzed object. The teacher initiates the students' thinking activity using the following questions: "How can this object be deteriorated?", "How can the occurrence of the greatest number of environmental hazards be provoked there?", "How can the occurrence of [such] undesirable ecological event be implemented on this object?". The purpose of the method is to develop professional thinking among students, since for the organization of "diversion", it is necessary to have deep professional knowledge and skills of technical creativity.
3. Involvement of students in the work of scientific departments at industrial enterprises (for example, NGDU "Prikamneft", OAO "PO ElAZ", OOO "SOLLERS-Elabuga"). The goal is to unite the scientific potential of the university, acting through the future engineers and administration of industrial enterprises, to solve real technical and environmental problems in the region.
4. Organization of environmentally-oriented pre-graduation production practice, since the study of environmental problems of the technosphere is impossible

without familiarization of students with its elements. Practice materials allow students to make in the reports the passports of environmental friendliness of equipment, technological processes and enterprises in general. The goal is the formation of skills to conduct primary environmental expertise of projects.

5. Development of eco-oriented diploma project, based on the materials of pre-diploma practice (at the will of the student).

The experiment with introduction of the considered directions, with the aim of strengthening the practical component of ecological training for technical students has been carried out within 7 years (2010-2016). The base of the experiment was the Naberezhnye Chelny Institute of the Kazan Federal University; the total number of participants was 293 students.

Determination of the levels of activity of students' ecological position and the formedness of the working component of their environmental culture, as the main components of their meta-qualification, was carried out based on the analysis of thematic articles, the examination of techniques and technologies, reports of pre-diploma practice, preparation and presentation of environmentally-oriented projects, the involvement of students in the activities of scientific departments of industrial enterprises.

The processing of the results of the study showed the following changes in the experimental groups (in comparison with the findings of the ascertaining experiment):

- conative component was reflected in concrete actions of 87% of respondents; they revealed the ways to solve environmental problems;
- 78.5% of students mastered the ways of transferring environmental knowledge to real or projected activities (for example, ecological paint and varnish covering for drinking water sumps were developed, the project for processing glass wastes into foamed glass was created, etc.);
- 86% of future specialists were able not only to make environmental expertise of their own projects, but also to analyze the environmental expertise of existing projects and to highlight the shortcomings in them;
- 91.5% of students, who carried out eco-oriented graduation projects, found the ability to model their activities mentally and to predict the results. This ability, in particular, was reflected in the formulation of hypotheses and the objectives of educational research.

## Discussion

The results of the conducted experiment on modernization of the process of ecological training of students, having technical specialties, make it possible to note, that the representatives of experimental groups have formed:

- understanding of the social importance of engineering and environmental activities, and responsibility for the results of their work;
- experience in predicting the consequences of technical decisions, taken at the level of separate elements of the technosphere;
- the ability to connect environmental knowledge with future professional activities, to carry out basic procedures of environmental expertise, to design innovative technical objects.

In addition, students, working on the experimental program, differed in the variability and goal-oriented cognitive activity, their own vision of the essence of environmental problems, the ability to predict their development and to give recommendations on reducing their negative impact. And since these characteristics were earlier distinguished by us as the signs of a specialist's meta-qualification, we can assume, that during the experiment its foundations were successfully laid.

Statistical indicators confirmed the veracity, and the duration of the experiment - the reproducibility of the results.

## Summary

1. One of the factors of sustainable development of modern society is professional engineering activity, since it can ensure the compatibility of the technosphere elements with the laws of development of biological world. This, accordingly, targets the process of training of future engineers on forming a meta-qualification, including the ability and readiness to realize themselves in eco-oriented professional activities.
2. Formation of the meta-qualification of the future engineer is considered in dialectical unity with the formation of his ecological culture.

3. The effectiveness of the process of formation the ecological culture of the future engineer will increase with the strengthening of the practical component of the process of his environmental training.

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