

LEASECON 2021  
Conference on Land Economy and Rural Studies Essentials**FORMATION OF ENVIRONMENTAL COMPETENCE OF  
GRADUATES OF A TECHNICAL UNIVERSITY**

Nina Y. Bugakova (a)\*, Valentina A. Danilenkova (b), Ekaterina A. Karelina (c),  
Tatyana V. Vasilyeva (d), Vladimir I. Eremin (e)

\*Corresponding author

- (a) Kaliningrad State Technical University, Sovetsky ave., 1, Kaliningrad city, Russia, bugakova@klgtu.ru,  
(b) Kaliningrad State Technical University, Sovetsky ave., 1, Kaliningrad city, Russia, zvez-da39@mail.ru,  
(c) Moscow State Technological University Stankin, Vadkovsky lane, 1, Moscow, Russia, .karelina@stankin.ru  
(d) Moscow State Technological University Stankin, Vadkovsky lane, 1, Moscow, Russia, t.vasilyeva@stankin.ru  
(e) Moscow Automobile and Road Construction State Technical University (MADI), Bronnitsky branch, Novo-Bronnitskaya st., 50, Bronnitsy, Russia, bronmadi2@mail.ru

**Abstract**

This article substantiates the idea that the problem of formation of environmental competence in the field of production safety in technical universities has not been sufficiently investigated: a comprehensive system of environmental knowledge, skills, actions in conditions of environmental risks in the process of studying professional disciplines has not been developed. The need to study the formation of environmental competence in the field of production safety is especially necessary in maritime educational institutions, since graduates are marine specialists who must be able to independently make decisions in isolated conditions, taking into account the requirements of the International Conventions in the field of maritime safety. The article pays special attention to the methods of competence-risk and situational-risk approaches as the basis for building a model for the formation of environmental competence of a graduate of a maritime university in the field of production safety. The conditions for the phased formation of personal and professional characteristics of the environmental competence of cadets are determined. The authors propose criteria for assessing the level of formation of environmental competence of a university graduate. Based on the analysis of the personal characteristics of university graduates, the level of formation of environmental competence is determined. The concept of formation of environmental competence of a graduate of a maritime university in the field of production safety developed by the authors provides training of a marine specialist in the field of production safety.

2357-1330 © 2022 Published by European Publisher.

*Keywords:* Competence formation, environmental competence, production safety, risks



This is an Open Access article distributed under the terms of the Creative Commons Attribution-Noncommercial 4.0 Unported License, permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## 1. Introduction

As you know, the development of engineering education is aimed at the content of environmental training of engineering personnel responsible for environmental safety at work. Today, when changes in the environment have raised the question of the survival of mankind, the training of engineers is a key task in solving the problems of personal protection and environmental protection (Federation of European National Associations of Engineers-FEANI).

The Federation of European National Associations of Engineers (FEANI) evaluates engineering training programs based on competence in relation to the environment and society. In relation to the specifics of technical education, the problem of competence in the field of environmental ecology is of particular importance, since students during the training period must learn to work in special, extreme conditions - conditions of increased risk and responsibility. On the example of marine technical universities, the need for environmental training of specialists has led to the need to change approaches to the formation of competence in the field of marine ecology and the operation of water transport. As you know, the professional activity of a seafarer is associated with the risks of extreme situations that can cause negative consequences for human life and the natural environment. Marine specialists who are at sea for a long time must make competent decisions on their own in various environmental situations: reducing accidents, risks, security threats, and environmental pollution.

Thus, the formation of environmental competence in the field of industrial safety of graduates of the maritime university acquires an important theoretical and practical significance. First, the requirements of International Conventions are aimed at the formation of competencies in various areas of safety; professional standards define the labor functions of marine specialists in the field of environmental ecology, human ecology, and industrial ecology; the requirements of the Federal State Environmental Standards are aimed at the formation of competencies (universal, general professional, professional, special, etc.). Second, the maritime university should create conditions for the formation of students' environmental competence and use educational technologies aimed at studying environmental risks, identifying hazards, designing scenarios for their development, reproduction and risk management. As the analysis of the survey conducted in 2016 in the specialty "Navigation" showed, the cadets have a low level of formed environmental competence in the field of industrial safety (18% of 254 people respondents) (Danilenkova, 2018).

## 2. Problem Statement

Thus, we concluded that the problem of the formation of environmental competence in the field of production safety has not been sufficiently studied at the maritime university. The place of risks and their influence on stress resistance, on the level of adaptation of cadets have not been determined. The system of environmental risk management processes has not been identified. The system of educational technologies has not been developed to ensure the formation of environmental competence in a university graduate. There are no principles and methods for constructing a theoretical and practical model for the formation of environmental competence in a university graduate. Based on the foregoing, the relevance of

this study is determined by the need to develop and substantiate the pedagogical concept of the formation of the environmental competence of graduates of the maritime university.

### **3. Research Questions**

- The first is the concept of forming the environmental competence of a graduate of a maritime university in the field of production safety.
- The second is competence-risk and situational-risk approaches as the basis for the formation of a model of environmental competence of graduates of a technical university.
- The third is conditions for the gradual formation of personal and professional characteristics of environmental competence of cadets.

### **4. Purpose of the Study**

The purpose of the research is development and experimental verification of a model for the formation of environmental competence of a graduate of a maritime university in the field of production safety.

### **5. Research Methods**

When performing the work, the following methods were used: situational-risk, competence-based approaches as the basis for building a model for the formation of environmental competence of a graduate of a maritime university in the field of industrial safety.

### **6. Findings**

Various environmental situations arising in educational and then production activities require their resolution taking into account safety. For this, it is necessary, depending on the environmental situation, to own a system of environmental knowledge, skills, abilities, actions, that is, to be competent in making effective management and technological decisions (Bugakova, 2016). Based on this, in our study, we applied a situational-risk approach, which is aimed at determining the needs of students in recognizing educational, educational, professional, industrial environmental risks by simulating various extreme situations that arise in the educational and then in the industrial environment to ensure personal safety, environmental safety and production (Baeva, 2005; Bugakova, 2016).

During the study, we came to the conclusion that the basis for designing a model for the formation of environmental competence is the search for avoiding losses arising from the action of various risks. One of the aspects of the formation of environmental competence is the conditions for the development of the graduate's personal characteristics: environmental friendliness, adaptability, stress resistance, communication.

The competence-risk approach puts forward in the first place the study of competencies in conjunction with environmental risks, knowledge of which will ensure safety in production, resolve

conflicts, adapt to various environmental situations, be resistant to stress (Chernova & Kudryavtsev, 2003).

The structure of the model is step-by-step and provides a level-by-level formation of environmental competence of cadets, which allows us to trace the process of development of students' relevant environmental knowledge, skills, and actions.

The formation of environmental competence of cadets in their development goes through three stages: the first-knowledge, the second-skills, skills; the third-skills, actions, control. At the same time, it is very important to determine the sources of environmental risks and their impact on environmental situations in the educational and industrial environment at each stage, depending on the period of study at the university (Danilenkova & Samsonova, 2015).

For clarity, we present the generalized content of environmental competence in the field of production safety of a marine specialist in a tabular form (Table 01).

**Table 1.** Step-by-step formation of environmental competence of industrial safety of a graduate of a maritime university

| The first stage – knowledge  | The second stage – skills and abilities  | The third stage – actions and control  |
|--|--|--|
| <p>* Personal environmentally competencies: adaptability - the importance of environmental knowledge for identifying risks; stress resistance - resistance to problematic risk situations when solving problems; the ability to determine and implement the priorities of their own activities on the basis of self-assessment and self-education.</p> <p>*environmental competencies: satisfaction with the environment, communication - the ability of students to engage in the educational environment of the university on the basis of interaction and cooperation; organize work in groups to solve risky tasks; maintain a level of physical fitness to ensure a healthy lifestyle, able to solve or avoid conflicts through environmental training and education.</p> <p>* production competencies - the ability to carry out a critical analysis of risky, problematic situations based on a systematic approach, to develop a strategy for solving risky, environmental problems, to learn to recognize and prevent risks; learns English as the basis of communication</p> | <p>* Personal environmentally competencies: development of levels of adaptation, stress tolerance, based on the development of the ability to be able to apply methods of critical analysis of risk situations; develop a team strategy for management decisions; adapt to the conditions of industrial swimming practice, show resistance to environmental educational and professional risks.</p> <p>* environmental competencies are characterized by the development of satisfaction with the environment, the level of communication, the level of conflict.</p> <p>These include organizing work in groups to create exploratory risk projects; resolving conflicts through environmental training and education, and maintaining a level of physical fitness to ensure a healthy lifestyle.</p> <p>* production competencies are characterized by further development of environmental friendliness, communication skills at a higher level. These include: the ability to carry out a critical analysis of risky, problematic situations based on a systematic</p> | <p>* Personal environmentally competencies: the formation of levels of adaptation, the degree of stress resistance, based on the ability to act in critical risk situations with the ability to make decisions in conflict situations. Adaptability to various situations; development of cognitive abilities (intelligence); stress resistance in extreme situations, balance, self-control; efficiency, endurance, non-conflict, ability to work in a team; responsibility; motivation for professional activity; environmental conditions are characterized by the level of formation of satisfaction with the conditions of the environment, the conditions of production; the level of formation of communication, the level of conflict through actions when making managerial and technological decisions in the interaction and cooperation of students-teachers-university management.</p> <p>* production competencies are characterized by environmental friendliness, communication skills include: the ability to act independently in conditions of danger; anticipate dangerous</p> |

skills in production activities; develops the ability to independently and collectively solve risky environmental situational problems; learn to use information on the prevention of environmental risks, safety technologies and control over their implementation in the first and second years of training at a maritime university.

The structure of the first stage consists of risk-knowledge: knowledge of the content of environmental risks; the ability to analyze and comprehend; the ability to recognize risks; basic environmental knowledge; adaptation to the maritime profession.

Communicative and motivational: ability to criticize and self-criticize; interpersonal skills.

Ecological-practical: the ability to apply environmental knowledge in practice; research skills; ability to learn; ability to adapt to environmental situations. At the first stage, such qualities of a marine specialist are formed as adaptability to training at a maritime university, to a maritime profession, to educational ecological risks, stress resistance to conflicts, communicativeness in communication and cooperation, understanding the importance of environmental knowledge for further professional activities.

approach, develop a strategy for solving risky, environmental project tasks on an electronic computer, are able to use ecological risks for the development of risky projects; learns professional English as an important component of communication in production activities; they are able to see the dangers and threats that arise in the process of information processing, and comply with the basic requirements of environmental safety. Ability to apply: environmental knowledge and skills, justify, predict, design, manage educational and professional risks, taking into account the system of national and international requirements, moral aspects of the activity.

The following skills are developed: planning, creating programs and methods for conducting research on educational and professional risks using information on their prevention in the third and fourth years of training at a maritime university.

The structure of the competence of environmental safety of production includes a knowledge-risk component based on the ability to find and analyze information from various sources; solve risky problems; make decisions and influence the environmental safety of the educational environment.

Communicative and motivational: motivation for environmental education, to preserve their health; the ability to work in a team; the ability to communicate with each other, with the teacher, the university administration; the ability to work in an environmental safe educational environment.

Environmental-practical: the ability to apply environmental knowledge in practice; research skills; ability to learn; the ability

situations, scenarios of their development and are ready to manage risks in production activities, can act to ensure the safety of life in emergency situations, are ready to take responsibility for making technological and managerial decisions. Graduates possess a comprehensive system of humanities, natural sciences and mathematics, focused on production. The ability to independently acquire and use a system of environmental knowledge and skills in practical activities with the help of information technologies. Students are able to act in conditions of danger and threats arising in the process of information processing, know and comply with the requirements of environmental safety. They can determine the causes of the accident, analyze it, and make their own decisions. The ability to apply environmental knowledge and skills, to justify, predict, design, and manage production risks, taking into account the system of national and international requirements, and the moral aspects of the activity. The ability to develop plans, programs and methods for conducting research on the most dangerous objects in production, aimed at managing the quality of environmental training of marine specialists. The ability to make managerial and technological decisions in regular and extreme situations; the ability to assess risks, determine the factors of their occurrence, be sociable and fair in relationships with others.

The structure of the competence of the environmental safety of production of a marine specialist includes a knowledge-risk component: the ability of students to act and find effective environmentally-oriented solutions; leadership; understanding of environmental

---

|                                       |  |
|---------------------------------------|--|
| to adapt to environmental situations. | risks and their threats; ability to work independently; development and management of environmental projects; initiative, responsibility, desire for professional growth; readiness to update the manifestation of competence in a variety of environmental situations for solving production tasks.<br>Communicative and motivational: motivation to cooperate and interact in making environmentally-oriented decisions, the ability to work independently in an environmentally safe production environment.<br>Environmental-practical: adaptation to the dangers of the maritime profession, the manifestation of a sustainable interest in environmental knowledge, skills; the ability to work in a team; possession of methods of self-regulation of behavior and methods of constructive resolution of conflict situations; skills and actions to make responsible management and technological decisions in risky, environmental situations. |
|---------------------------------------|--|

---

Given that the competence of the environmental safety of the production of a marine specialist is formed in stages, taking into account the requirements of the Federal State Environmental Standards, International Conventions and professional standards, we need to determine the indicators and evaluation criteria.

The criteria for assessing the state of formation of environmental competence of a university graduate will be the satisfaction of students, the importance of conditions for improving the quality of environmental training of students, environmental friendliness as a means of ensuring safety at work.

The characteristics of the level of environmental competence formation at each stage will be the personal qualities of the graduate: adaptability, stress resistance, communication skills. Indicators of the level of environmental competence of a marine specialist will be the analysis of the state of risks, the ability to manage and anticipate them to eliminate or limit threats in production activities. Tables 02-03 show the dynamics of the growth of the levels of environmental competence in the graduates of the maritime university (Tables 02-03).

At this stage of the experimental study, based on the methods of mathematical statistics (the T-Wilcoxon criterion), it was found that according to these criteria, the level of environmental competence of cadets is growing. The following indicators are of particular importance for our study: stress resistance

and environmental friendliness, since their dynamics indicate the formation of the level of environmental competence of a graduate of a technical university. Since these indicators are responsible for the quality of environmental training of students, it can be concluded that it is necessary to take into account risks in order to perform practical tasks in emergency situations during the period of study at the university.

**Table 2.** Dynamics of the growth of the levels of environmental competence in the graduates of the maritime university

| Indicators (personal)  | Initial stage of the experiment – 2017 (units) | Intermediate stage of the experiment-2018 (units) | Final stage of the experiment – 2019 (units) |
|------------------------|--|---|--|
| 1 communication skills | 4.6  | 7.1   | 9.3  |
| 2 adaptability         | 5.8  | 7.3   | 9.1  |
| 3 stress-resistance    | 5.0  | 7.3   | 9.1  |

**Table 3.** Dynamics of the growth of the environmental competence levels in the graduates of the maritime university

| Indicators (personal)        | Initial stage of the experiment – 2017 (units) | Intermediate stage of the experiment-2018 (units) | Final stage of the experiment – 2019 (units) |
|------------------------------|--|---|--|
| 1 complacency                | 3.2  | 6.1   | 8.9  |
| 2 significance               | 4.8  | 6.0   | 9.8  |
| 3 environmental friendliness | 4.5  | 6.9   | 9.2  |

After analyzing the indicators of the formation of the level of environmental competence of a graduate of a technical university at the stages: knowledge, skills, actions and control, we came to the conclusion that the competence-risk and situational-risk approaches can improve the level of environmental training of cadets. Personal (adaptability, stress tolerance, communication skills) and professional (satisfaction, significance, environmental friendliness) components of the environmental competence model will ensure safety at work, namely, the ability to manage and anticipate risks to eliminate or limit threats in emergency situations.

The analysis of the above data shows that the concept of forming the environmental competence of a graduate of a maritime university in the field of industrial safety has great potential:

- it creates conditions for the gradual formation of personal and professional characteristics of environmental competence of cadets on the basis of environmental knowledge, skills, actions and control;
- it ensures the application of environmental knowledge in the practice of risk management in the field of production safety.

## 7. Conclusion

Thus, as a result of the research, a scientific result was obtained, the essence of which is the step-by-step (knowledge, skills, actions and control) formation of environmental competence of graduates of a technical university on the basis of competence-risk and situational-risk approaches. Competence-risk and situational-risk approaches in the field of environmental training of students allow us to form a model of environmental competence in the field of industrial safety of graduates of a maritime university, taking

into account the requirements of International conventions, professional standards, and Federal State Educational Standards. The effectiveness of the model for the formation of environmental competence of graduates of a technical university depends on the study of risks, hazard identification, design of scenarios for their development, reproduction and management. The current state and trends in the formation of environmental competence of graduates of a technical university indicate that, along with the traditional concept of the educational process, competence-based risk and situational risk approaches based on the study and management of risks are increasingly used, thereby ensuring the quality of environmental training of students. Moreover, the results of the study indicate the need to form a model of environmental competence of graduates to ensure the safety of production.

## Acknowledgments

The study has been conducted in MADI as an activity under the project “Effective training model of technical discipline lecturers for the purpose of obtaining “International Educator of Engineering University” certificate - “ING-PAED IGIP”. MADI is recognized as a Federal Innovative Platform according to Order № 1580 from 25.12.2020 (registered on 03.02.2021).

## References

- Baeva, I. A. (2005). *Psychological safety in education*. Soyuz.
- Bugakova, N. Yu. (2016). Methods of research of the quality management system of higher education in a technical university. *System analysis in design and management*, 402-407.
- Chernova, G. V., & Kudryavtsev, A. A. (2003). *Risk Management*. Nauka.
- Danilenkova, V. A., & Samsonova, N. V. (2015). Environmental risks in the educational environment of a modern technical university. *Proceedings of the Baltic State Academy of Fishing Fleet: Psychological and Pedagogical Sciences (theory and Methodology of professional education)*, 3(33), 45-48.
- Danilenkova, V. A. (2018). Features of formation of competence of environmental safety of students of the maritime university. *Proceedings of the Baltic State Academy of Fishing Fleet: Psychological and Pedagogical Sciences (theory and methodology of professional education)*, 24(44), 264-268.