

## Formation of Professional Competences for Future Environmental Engineers Based on the Interdisciplinary Approach

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The article discloses new requirements towards future environmental engineers, who will be conducting environmental protection under new socio-economic conditions. The definition of professional competency of an environmental engineer is determined.

**Key words:** professional competency of environmental engineers, World Trade Organization, international trade, ecological problems.

In the framework of Russia's accession to the World Trade Organization (WTO) the new rules concerning the process of international trade, new standards for trading products, norms and principles, requirements for ecolabelling of goods and products have been introduced. These changes concern the issues of international relations' regulation in the sphere of environmental protection with an aim to preserve rational management of natural resources. This is strongly tied with the fact that current ecological situation can be characterized by a high level of ecological disaster risks, an increase of anthropogenic influence on nature, that require constant attention to the ecological problems and their efficient solution [1, pp. 216-218]. The most essential part of ecological problems' solution is the interdisciplinary approach to those phenomena of material world that are based on the biological laws, but are getting more and more involved in the spheres of social, technological, economical and political interests.

The accession of Russia to the WTO sets new requirements towards specialists, who are working for the environmental protection and are assuring environmental control of goods and products. These specialists are prepared by engineering universities, among which is the Kazan

National Research Technological University. The topical issue of training environmental engineers is the need to foster professional competency as a holistic integrative ability of a specialist that ensures his/her readiness for the efficient resolving of appearing problems.

In order to follow the new requirements set by the WTO, environmental engineers have to focus on the new standards, norms, by-laws, statutory regulation of the environmental state, methods and means for assessing the current state of the environment and its protection from anthropogenic influence. Thus, their professional competency has to include new knowledge, skills and professionally important personal attitudes that ensure efficient professional activities under the new conditions and allow for the environmental engineers to constantly develop their competency in the framework of dynamically changing conditions of the professional activities.

The World Trade Organization guides countries to follow and implement international standards – International Organization for Standardization (ISO), which assure an integrated international system of requirements towards the quality management of goods and services. One of the most important international

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standards is the ISO 14000. The subject of this standard is the environmental management system (EMS) that allows to efficiently balance economic increase of the company's income and preservation of the environment. One of the requirements towards future environmental engineers is to know the ISO standards and to be able to apply them within an organization [2].

The literature analysis and the analysis of regulatory sources permitted to determine that a modern environmental engineer has to:

- Possess knowledge of the environmental management system, environmental audit, environmental certification and licensing.
- Possess knowledge of the key definitions, terms and laws concerning international trade and ecology.
- Master the methods of environmental control, methods of environmental safety of produced goods.
- Understand the role of international trade in assuring global economic development.
- Understand the international system for environment protection.
- Apply the rules and norms of the WTO and mechanisms of the international economic cooperation for developing individual strategies in conflict resolution, etc.

Besides that, graduates should have fostered the following competences: the ability to apply modern informational technologies, the readiness to justify certain technical solutions, when developing technological processes, the ability to choose technical means and technologies aimed at minimizing anthropogenic influence on the environment. Professional competency of an environmental engineer, in the author's opinion, can be described as an integrative ability that assures readiness for efficient problem solution concerning rational environmental management, that includes the strive for mobilization of professional competences based on updating personal expertise for

successful conduction of activities on the environmental protection in the process of professional work.

Based on the interdisciplinary approach, the integration of sciences, social sciences, legal, ecological and economic knowledge, the training materials for "International trade and ecology" have been developed and implemented within the study course "Environmental management and environmental audit".

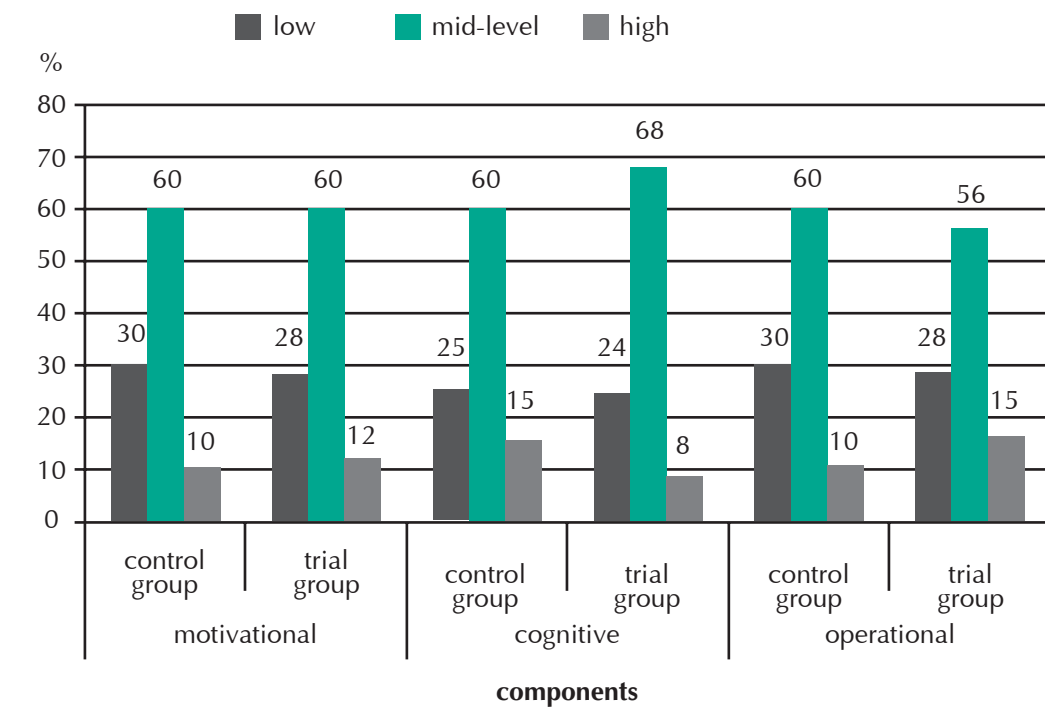
Moreover, an e-learning course "Virtual laboratory of an environmental engineer" has been developed and implemented. The course allows using informational and communicational technologies with an aim to increase the efficiency of students' continuing self-education, to create individual educational paths for future environmental engineers.

The trial work has been conducted during 5 years and has involved 4 stages. Aiming to determine the level of students' environmental culture a wide spectrum of diagnostic instruments has been used: an upgraded method for students' motivation diagnostics (S. Pakulina, M. Ovchinnikov), a questionnaire for determination of environmental culture level, a test "International trade and ecology" consisting of tasks on evaluating the level of ecological knowledge, understanding of international environmental standards and norms, specific tasks on understanding environmental problems, evaluation of projects according to the developed map of expert evaluations.

The results of this summative research showed that the level of professional competency of students in the trial and control groups turned out to be quite similar. A high level of motivational, cognitive, operational components of professional competency in both groups has a low value (Fig. 1).

On the summative stage students of the major «Environment protection and rational environmental management» and the major "Engineering environmental protection" participated in the trial. On

Fig. 1. Level of formation of students' professional competency components on the summative stage, %



this stage the structural functional model and the pedagogical conditions for fostering professional competency of future environmental engineers have been tested.

Students of the "Engineering environmental protection" major (20 people) followed the traditional educational program.

At the end of the study year there has been a secondary evaluation of the intensity of all the components that characterize professional competency of students from the trial and the control groups.

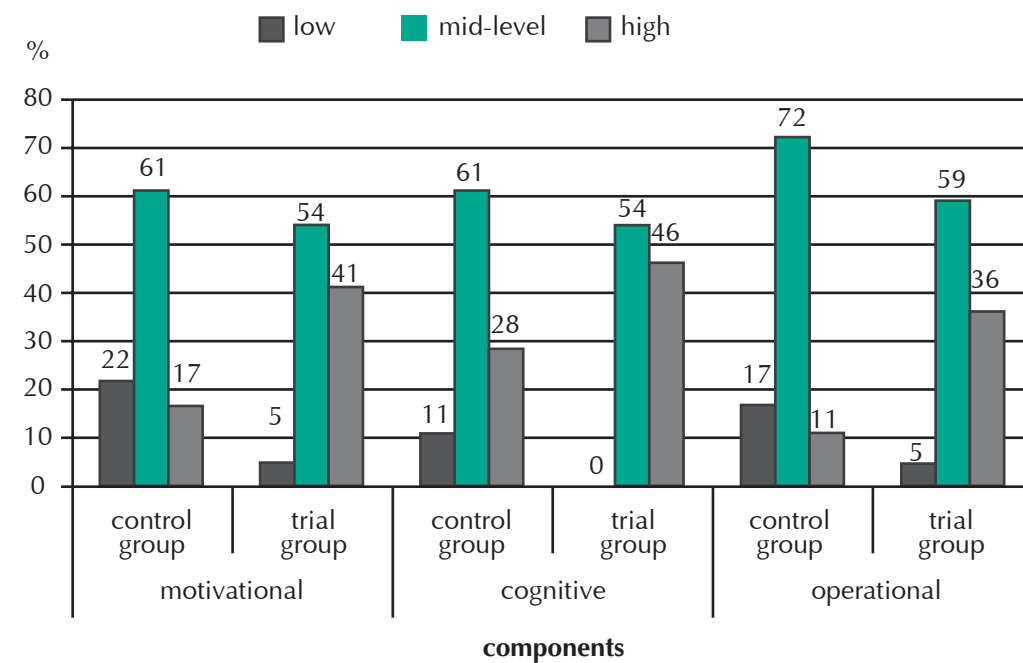
A high level of motivational, cognitive, operational professional competency component in the trial group has increased. A low level has increased significantly in the trial group (Fig. 2).

During the comparative educational experiment the contents of extracurricular modules have been updated, a set of disclosed problems has been extended, problems for project-based activities have deepened.

This experimental work served for the purpose of analyzing the results of a 3-year diagnostics of professional competency components' level of formation. Picture 3 shows the evaluation results of professional competency components' formation of the 4<sup>th</sup>-year students (Tab. 1).

One of the unbiased indicators of the developed model's and pedagogical conditions' efficiency for fostering professional competency of future environmental engineers is the students' participation in scientific conferences on environmental problems, their participation in environmental campaigns. On the summative stage of the research only 7% of students acknowledged participation in scientific research and conferences devoted to the environmental problems, and only 6% of them have taken part in environmental campaigns. On the formative stage of the experiment their number has increased to 24% and 12% accordingly. On the final stage of the

Fig. 2. Level of formation of students' professional competency components on the final stage, %



experiment 26% of students acknowledged participating in research activities, 12% stated taking part in conferences and

more than half of students acknowledged participating in environmental campaigns more than two times within one year.

Table 1. Level of formation of professional competency components of future environmental engineers, %

groups	Motivational				Cognitive				Operational			
	control		trial		control		trial		control		trial	
2011-2012 study year												
level	before	after	before	after	before	after	before	after	before	after	before	after
low	26,3	15,8	25	4,2	26,4	15,8	29,2	4,2	26,3	10,5	25	4,2
mid-level	63,2	73,7	62,5	62,5	52,6	57,9	50	62,5	57,9	68,4	58,3	50
high	10,5	10,5	12,5	33,3	21	26,3	20,8	33,3	15,8	21,1	16,7	45,8
2012-2013 study year												
low	31,6	15,8	30,4	4,3	26,3	10,5	26,1	4,4	26,3	10,5	26,1	4,3
mid-level	63,2	68,4	65,2	60,9	52,6	63,2	52,2	60,9	57,9	73,7	56,5	43,5
high	5,2	15,8	4,4	34,8	21,1	26,3	21,7	34,7	15,8	15,8	17,4	52,2

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