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UDC 006.9:378

Competency-Based Approach to Developing Educational Standard for Master's Program "Standardizatin and Metrology" at Northern (Arctic) Federal University n.a. M.V. Lomonosov (NArFU)

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The article presents the experience in developing educational standard for master's programs in standardization, metrology, and certification. Being developed in line with international practice, the standard extends the scope of professional activities, supplements cultural and professional competences with regard to ecological, economic and ethnic peculiarities of the Russian Arctic zone.

Key words: educational standard, competency-based approach, competence level, competences, master student's professional activity, educational technologies.

The Russian system of Higher Education is currently undergoing enormous changes due to the new requirements imposed by the labor market. To be more precise, employers are searching for the employees who have a wide range of knowledge and are able to adapt to the ever-changing workplace and make independent decisions. Therefore, upon completion, graduates should acquire practical knowledge and a variety of job-related skills.

At the same time, it should be noted that lecture classes prevail over practical ones in the Russian system of Higher Education. The problem arises from the "theoretical character" of the disciplines being taught, lack of active learning and teaching methods [1, 371-372]. Therefore, to meet the modern requirements of the labor market and be ready to train the graduates who are capable of adjusting to labor market demands, it is essential to revise the process of education by introducing the competency-based approach.

Leading Russian universities have been given the right to develop their own educational standards, i.e. university educational standard (UES). Being adjusted to the Federal State Educational Standards (FSES) of Higher Professional Education, these standards allow universities to ensure high education quality in accordance with international requirements. Since there is internationally recognized practice to estimate the quality of education by independent professional accreditation agencies, it is required to meet not only FSES of Higher Professional Education, but also accreditation agency requirements.

The mission of Northern (Arctic) Federal University (NArFU) is to provide a high-quality graduate training, as well as innovative scientific solutions in support of geopolitical and economic interests of Russia in the Arctic region by developing the system of continuous professional education, which integrates science and industry and incorporates the strategic partnership with consumers.

Since 1996, NArFU has successfully trained engineers in "Metrology and Metrological Support" and "Standardization and Certification", as well as engineer-managers in "Quality Management". The graduates of the university are much in-demand not just in the Arkhangelsk region but in the other regions of the Russian Federation, especially in its North-Western part. As the Arctic region is intensively being developed, there is an urgent need for highly-qualified specialists in standardization, metrology and certification.

Master program should be developed with regard to the up-to-date achievements in standardization, metrology, and certification. In addition, it should be in compliance with NArFU priority objectives and the 2010-2020 development plan.

Standardization, metrology, and certification are among the most important conditions for successful development of the university, particularly:

- high-tech production and industries;
- development of Russian European North and Arctic infrastructure;
- complex use of bio resources;
- development of northern (polar) medicine and public health service;
- environmental protection;
- development of social and humanitarian spheres of Russian European North and the Arctic.

When developing UES for education programs "Standardization and Metrology", the focus was made on the urgent market demands within the Arkhangelsk region and Northwestern Federal District, NArFU development priorities, interests of the Russian Federation in the Arctic, recent trends in European education and primary objectives of Russian education policy. UES is intended not only to promote the use of innovative teaching and learning methods, but also to provide such education programs that would compete at the international level. The main purpose of UES is to provide master's degree program in Standardization, Metrology, and Certification which aims to train graduates with such competences and skills that would help them to handle multiple tasks independently and find the solution how to enhance the quality of products and services provided by the enterprises of different legal forms.

In the course of UES development, the analysis of international experience in educational standard design was carried out. Therefore, we have considered the following documents, regulations, and standards: requirements and recommendations provided by the International Engineering Alliance "Graduate Attributes and Professional Competencies" dated 21 June 2013; the structure and nomenclature of bachelors/masters degree programs, as well as specialist's programs offered within the Bologna Process; requirements imposed to engineers by Engineers Mobility Forum (EMF), APEC Engineer Register, Fédération Européenne d'Associations Nationales d'Ingénieurs (FEANI); international criteria for engineering degree program accreditation, i.e. Washington Accord (WA), EUR-ACE Framework Standards for Accreditation of Engineering Programmes (EUR-ACE), including the criteria for public professional accreditation of engineering education programs provided by Association for Engineering Education of Russia (AEER); Standards and Guidelines for Quality Assurance in the European Higher Education Area [2, p. 26]. In addition, UES has been developed on the basis of outcome-based approach applied not only in educational standard design, but also in education quality assessment; European Credit Transfer and Accumulation System (ECTS); the rating system used to measure the achievement of the learning outcomes; asynchronous learning characterized by students working independently (Learning VS Teaching); student-centered teaching techniques. It is worth noting that the developed educational standard is in compliance with the international standard ISO 9001:2008 (IWA 2:2007) intended to manage educational processes in higher educational organizations within the quality management ISO/IWA 2:2007 [3, p. 10-15].

The developed UES is aimed at resolving the following tasks:

- to expand the field of master students' professional activity by teaching them how to certify and declare products, works, and services in practice;

ENGINEERING EDUCATION
17'2015

- to revise the competences in quality assessment and compliance certification with regard to FSES of Higher Professional Education and the recent changes in the legislative system of the Russian Federation and foreign countries;
- to define environmental, ethnic, economic, and other characteristics of products, works, and services provided under northern (Arctic) conditions in the process of standardization, certification, and metrology;
- to introduce module-based curriculum.

The basic difference between UES and FSES lies in the fact that the professional activity of the master students has been significantly changed in comparison with FSES. To be more precise, cultural and professional competences have been expanded. The cultural competences have been transformed to the cultural meta-competences of personal and professional development (CC-P), communicative competences, the competence of thinking principles and information culture (CC-I), and systems thinking competences (CC-S).

The competence of thinking principles involves the ability to analyze, synthesize, compare, contrast, and integrate data. It also includes the ability to think critically and solve problems within interdisciplinary framework (CC-I.1).

The communicative competence is the ability to use the language (native or foreign) correctly in resolving tasks in professional, educational, and scientific activities (CC-I.2).

The information culture involves the knowledge in contemporary information and bibliographic culture, which can be applied in resolving complex tasks in professional, educational, and scientific activities by using information and communication technologies (CC-I.3).

The social responsibility is the ability of students to assume social, economic, and environmental responsibility in their future professional and scientific career. It is the ability to observe professional and scientific ethical standards, as well as to assume responsibility for decision-making and assume extra responsibilities during emergencies (CC-P.1).

Personal development competence involves initiativity, creativity, self-awareness, result orientation and focus on success achievement in all spheres of professional activities. It also involves the commitment to life-long practice toward self-development (CC-P.2).

The project management competence is related to ability to manage projects within different spheres of professional activity (CC-S.1).

The competence to apply theoretical data includes the ability to use the acquired knowledge and skills in practice for profession-related problem solving (CC-S.2).

The competence in science refers to the ability to analyze and apply new methods of research, change the research area within the professional activity. It also refers to the ability to independently conceive, formulate, and conduct research, as well as to implement innovations within the professional activity (CC-S.3).

The professional competences have been expanded by a number of special professional competences (SPC). In accordance with UES, a graduate must acquire the following SPC:

- demonstrate high level of knowledge in metrology, standardization, quality assessment and compliance certification, up-to-date theories, interpretations, methods, and technologies (SPC-1);
- be able to analyze and interpret innovations in theory and practice, demonstrate enough competence in independent research, and be able to interpret results at high level (SPC-2);
- demonstrate the willingness and ability to make a significant and original contribution to metrology, standardization, and compliance certification, as well as enough knowledge and skills for dissertation and thesis writing (SPC-3);
- demonstrate original thinking and apply creative approach to handling practical tasks in metrology, standardization, and certification (SPC-4);
- be able to identify and analyze the requirements to the subjects of standardization, metrology, and certification, as well as to complete detailed technical enquiries (SPC-5);
- be able to integrate possible solutions of a problem or identify approaches to developing a project in standardization, metrology, and certification (SPC-6);
- demonstrate the ability to evaluate the approaches to the quality requirements for products, works, and services and predict the consequences if products and services do not meet the requirements (SPC-7);
- be able to formulate and resolve the tasks in metrology, standardization, and certification by using contemporary information and communication technologies (SPC-8);
- be able to document the processes of measurement system development at all stages of lifecycle (SPC -9);
- be capable of using technological and functional standards, contemporary models and methods of quality and safety assessment in measurement tool design and testing (SPC -10);
- demonstrate the ability to inspect organizations, reveal the metrology needs of consumers, develop the requirements to measurement system, participate in application and information process reengineering (SPC -11);
- demonstrate the willingness to participate in measurement system implementation, testing, and adjustment (SPC -12).

Besides, in accordance with labor market demands, the workload (hours/credits) of definite program cycles has been changed. Particularly, the workload (hours/credits) of the professional cycle has been increased due to a slight reduction in Basic Sciences cycle. It is possible now to deliver not only certain courses, but also the entire education program in a foreign language.

To provide student academic mobility, the credit-rating score has been attributed to each program course (module). This allows evaluating the level of performance that students have achieved studying at different universities.

During the classes and research works, it is recommended to apply the following educational technologies: systematization and visualization of knowledge (lecture-visualization, tests); information and communication technologies to shape and develop interpersonal and professional communication; interactive teaching methods (seminar-discussion); case-study; internet resources and distant information technologies.

The qualification of the faculty members, lab facilities and vast experience in organizing student research work guarantee high quality of master students training. NArFU ensures fulfilment of all the requirements in the implementation of the master program in terms of required facilities, lab equipment (availability of the facilities is currently 80-90%), and library resources for each education program course.

The developed UES significantly expands the field of master students' professional activity since it provides students not only with theoretical knowledge in standardization and metrology but also with practical skills and attributes. These spheres of professional activity are associated with a consumer of products, works, and services as they directly ensure consumers' safety and represent the final stage in quality assessment of products, works, and services. The sphere of assessment and compliance certification has been significantly changed in terms of laws and regulations. Therefore, unlike

FSES, the developed UES which is aimed at developing required competences in metrology and certification is of significant practical value.

Moreover, within the framework of university development plan implementation and the Arctic cluster orientation, the UES makes it possible to identify quality features of the products offered by the northern enterprises with due regard to environmental, ethnic, economic, and other characteristics of northern (Arctic) region. This allows graduates to carry out essential comparative analysis of the certification criteria used in the Arctic countries and national certification systems paying special attention to environmental issues.

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Curriculum Design in Engineering Education and the Role of Partnerships

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Engineering schools have to be aware of three important levels of profile analyzing to guarantee the employability of their graduates: The local market needs in skills, the companies needs in human resources technically, the international openness and importance of partnerships and patronage activities. At Esprit, these three points are considered as key-metrics to design the curriculum in engineering education.

Key words: teaching, learning, design, curriculum, engineering, assessment, market needs.

1. Introduction. When it is about seeking what skills fit the new jobs required in every country, it's a whole ecosystem behind that, we have to review and study deeply. We cannot mention the market needs in skills, soft and technical ones, without talking about its needs in human resources. Do the companies require specific technical competences, certified engineers, specialists, excellent products sellers... These are the questions the engineers' schools boards ask frequently. Companies' needs in engineers doesn't only concern the local market but the international one too. We will try to explain how these three components are the basics to design a flexible curriculum in engineering education.

2. Local market need. What enterprises managers seek when they want to hire engineers vary from a period to another depending on the economic and political status of the country. Which fields are more important than the others and in which competences we have a lack in are the most important ways of measuring how to grow the company. Let's take for example the IT domain, simply, we can say that as it is empowering every field and always useful, it never dies as an important tool to make services more and more automatic and faster. For the case of Esprit, the best private engineering school in Tunisia, we don't only reform the learning curriculum but the whole university environment to let each entity play its role to constitute this mosaic of ecosystem to keep leading and graduating the best of Tunisian engineers among public and private universities. In fact, we learn a lot on the study of the existing solutions in the local market to inspire teachers choosing the best case-studies to guide students in every level during their engineering studies to be able to develop in their own ability for solving problems and here we can talk about the Problem Based Learning (PBL) concept which is the basic and most important step in designing the curriculum by adopting the active pedagogy. We mean by this way of teaching that students, by time, become able to detect the specific needs technicality of the enterprises in skills that can contribute in developing solutions that can ameliorate the entire economical chain in every industrial domain. So if we prepare engineering students think problem-solution, we'll obtain a very constructive way of thinking and operating in the professional market. At Esprit, and since the 1st year of studying, we push the new generation to think differently by bringing innovative ideas and pitching them in front of experts in entrepreneurship. So we don't prepare them only to be

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