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Designing ICT Education Programmes Based on Professional Standards

Tver State University
I.V. Zakharova, S.M. Dudakov, I.S. Soldatenko

I.V. Zakharova

S.M. Dudakov

I.S. Soldatenko

The article describes experience of the Russian universities in designing education programmes in the field of information and communication technologies based on professional standards.

Key words: competence approach, engineering education, professional standards, federal state educational standards.

Introduction

In 2011, the third-generation federal state educational standards were implemented in Russia. One of the key particularities of these new standards is competency approach to education, which means that the emphasis has shifted from education content towards learning outcomes clear for all interested stakeholders – employers, teachers, students. Learning outcomes are described in the form of competencies comprising knowledge, abilities, and skills, professional experience and personal qualities, which the graduate should develop and obtain.

At present, Russian universities should develop education programmes, which meet the professional standards, and an adequate assessment system. In this regard, the experience of leading Russian university can be rewarding: implementing the international project METAMATH "Modern Educational Technologies for Math Curricula in Engineering Education of Russia" and the national scientific and methodological projects "Scientific and Methodological Support for Developing Exemplary Principle Professional Education Programmes (EPPEP) for Different Profiles", "Models for Harmonizing Professional Standards and Federal State Educational Standards of Higher Professional Education (FSES HPE) in Mathematics, Natural Sciences, Farming Sector and Agricultural Sciences, Social Sciences, Humanities (Specialist's, Bachelor's, and Master's Degree)" [1, 2]. The present paper describes the experience in the sphere of Information and Communication Technologies (ICT) education.

Competency approach in education

The level of mathematical knowledge is an essential aspect of successful engineering and natural sciences education, since mathematics is the key subject in engineering. If the second-generation standards prescribed the disciplines to be learned and described the content, the third-generation educational standards are a kind of framework. Every university is to select the disciplines to be taught and define the number of credits, which does not always ensure profound mathematical and engineering education [3]. Some careless duty-holders thus get an opportunity to reduce the number of hours for mathematical disciplines taught within ICT engineering profile and lower other parties' sights. Today, universities should be very careful in selecting the content of mathematical disciplines and take into account future professional activities and tasks [4].

When designing and implementing education programmes, one should stick to competency approach, which aims at developing general, professional, and personal competencies of higher engineering school graduates. The competency approach implies:

- listing competencies essential for Specialist's, Bachelor's, and Master's degree;
- designing engineering education programmes based on professional standards.

An attempt to resolve these tasks was made within the scope of the project "Scientific and Methodological Support for Developing Exemplary Principle Professional Education Programmes (EPPEP) for Different Profiles". The project stakeholders designed the exemplary principle education programmes aimed at developing general and professional competencies within consolidated profiles (UGSN). Professional competencies for Bachelor's and Master's degree, UGSN 02.00.00 being revised, they suggested an updated list of competencies with due regard to particular profiles and mathematical education [5].

According to the methodological recommendations passed by the Ministry of Education and Science of the RF dated 22.01.2015, when designing principle education programmes, universities and institutes should take into account the relevant requirements of the professional standards. The professional standard is description of qualification which a graduates need to perform this or that professional activities. The foundation of educational standards should rest on professional competencies focused on employment functions (professional activities), which are prescribed by the professional standards.

Brining the sections of FSES HPE into compliance with professional standards

One of the ways to enhance education programmes and bring them into compliance with the professional standards was suggested within the project "Scientific and Methodological Support for Developing Exemplary Principle Professional Education Programmes (EPPEP) for Different Profiles". The project stakeholders designed the exemplary principle education programmes aimed at developing general and professional competencies within consolidated profiles (UGSN) [6, 7].

We analyzed the content and structure of the professional standards and came to the conclusion that there is no unambiguous correlation found between professional spheres and educational profiles. Therefore, in FSES 3+ we have identified the "core" cultural and professional competences, which are independent of particular professional activities and programme profile. The "core" is the major part of the education programme, it is fundamental and unchangeable. The "optional" part should be focused on specific employment functions or professional activities, prescribed by the professional standards (if there are any). This part should be renewable and easily updated to cater the demands of labour market.

[6, 7] describe the exemplary principle education programme for Bachelor's and Master's degrees "Mathematical and Natural Sciences" developed by the project stakeholders within UGNS 02.00.00 "Computer and Information Science". This programme comprises 6 profiles (both Bachelor's and Master's degrees):

- Mathematics and Computer Science.
- Fundamentals of IT and Information Technologies.
- Information Systems Software and Administration.

We analyzed if the enhanced general professional competencies (OOPK) comply with generalized employment functions (GEF) and employment functions (EF) connected with professional activities of Bachelor's and Master's degree programmes' graduates.

To design the exemplary education programme "Mathematical and Natural Sciences" within UGNS 02.00.00 "Computer and Information Science", we selected the professional standards and generalized employment functions (GEF) connected with professional activities of programme's graduates. The criteria were as follows:

- type of professional activity described in professional standards;
- level of qualification described in professional standards and correlated with the academic degree;

- requirements of employers whom the programme designers cooperate with.

Many IT professional standards contain GEFs implying software design:

- POU integration and software testing;
- requirements engineering and software design (professional standard "Programmer");
- design of software architecture options;
- selection and assessment of a software architecture option;
- software implementation (professional standard "Software Architect");
- component-based software engineering (professional standard "System programmer").

As a result, one of the suggested GPCs for Bachelor's degree has been formulated as OOPK-II (B_02) – an ability to design, analyze, and implement algorithms to resolve professional tasks.

Based on GEFs comprising EFs and their components (knowledge, skills, and professional activities) one can split competency development into learning stages and identify relevant learning outcomes. As an example, let us consider OOPK-II map tile (tabl. 1).

It is clear that education programmes should be provided with testing and assessment tools, which enables evaluating the level of the competency development [8-12]. Therefore, development of efficient testing and assessment tools is another challenge for teaching community [13].

Besides general professional competencies, the educational standards include professional competencies (PC) focusing on a particular type of activity. The idea of professional competency design is approximately the same as that of general professional competency, but the professional competency includes a smaller number of employment functions. For instance, the employment function "determining probable types of every component" in the professional standard "Software Architect" corresponds with the research activity, while the employment functions:

- designing database back-up procedures,
- designing of database recovery procedures
- in the professional standard "Database Administrator" correspond with project, production and engineering activities.

Table.1. Enhanced general professional competency OOPK-II: map tile

Stage (level) of competency development	Expected learning outcomes (indicators of relevant level)
First stage (level) Ability to implement basic algorithms into software	Z (OOPK-II) –1: to know programming languages
	Z (OOPK-II) –1: to know basic algorithms of information processing
	U (OOPK-II) –1: to be able to use programming languages to implement algorithms
	V (OOPK-II) –1: to be able to use software for design
Second stage (level) Ability to design and analyze software to resolve various tasks	U (OOPK-II) – 2: to be able to design software packages
	V (OOPK-II) – 2: to be able to analyze software
Third stage (level) Ability to design new algorithms and measure their efficiency	Z (OOPK-II) – 3: to know common measures of algorithm efficiency
	V (OOPK-II) – 3: to be able to design and enhance algorithms
	V (OOPK-II) – 3: to be able to determine the level of complexity and measure algorithm efficiency

Conclusion

In this paper, we have described the principle of competency design for IT graduates, which is based on the professional standards.

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Towards the Issue of Quality of Engineering Education

National Research Tomsk Polytechnic University
S.B. Mogilnitskiy, E.E. Dementeva

The article considers issues related to the quality assurance of higher engineering education, examines the global experience in this regard and ways to deal with the challenges. It is shown that one of the principal mechanisms to ensure and assess the quality of education is a professional and public accreditation (PPA) of education programmes (EP). The purposes and objectives of the professional and public accreditation, benefits for graduates of accredited programmes in the career development of a professional engineer are described. The practice and outcomes of the activities of the Association for Engineering Education of Russia (AEER) in the accreditation of education programmes in the field of engineering and technology are presented.

Key words: educational trends, professional and public accreditation, university rankings.

Introduction

One of the basic factors of sustainable economic development is significant improvements in staffing the enterprises that are involved in developing and implementing the breakthrough technologies. It is impossible to resolve this task without strengthening the entire system of higher professional education. Therefore, a new approach aimed at solving the most serious problems faced by the mankind in the XXI century is being implemented. The priorities of the sustainable socio-economic development of the society are as follows: improvement of citizens' life quality, economic growth, science, technologies, education, health and culture, ecology and environmental management [1]. A new paradigm of engineering education appears. Its main feature is that education has shifted the focus from knowledge transmission to practice-oriented lifelong education that rests on the fundamental theories. In view of the above, Russian high school is currently facing the task to assure high quality of Russian education and succeed on the global educational market.

Trend and tasks of Higher Professional Education

The following trends can by identified in Russian and foreign systems of higher professional education:

- The breaking down of the national borders: the increase in student and faculty staff mobility, development of international partnerships, participation of the international experts in thesis defense, the growth in import and export of education services and research, emergence of global players on the Russian education market and the risk of "education sovereignty" loss. The only way to survive for the higher professional education is to train graduates for a special niche or sector of economy, i.e. to take on the role of "an agent" of region/sector development.
- Orientation of universities towards the demands of the society and economy: whole scale long-life learning, devaluation of traditional diplomas, emergence of new assessment bodies (independent certification agencies, standards of leading companies (Microsoft certification)), gradual privatization of higher education by business, building of new-type campuses (educational

S.B. Mogilnitskiy

E.E. Dementeva