The criteria of optimization of training specialists for the nuclear power industry and its implementation in the educational process

S V Lavrinenko¹ and P I Polikarpov¹

¹National Research Tomsk Polytechnic University
Russia, 634050 Tomsk, Lenina ave., 30

Abstract. The nuclear industry is one of the most important and high-tech spheres of human activity in Russia. The main cause of accidents in the nuclear industry is the human factor. In this connection, the need to constantly analyze the system of training of specialists and its optimization in order to improve safety at nuclear industry enterprises. To do this, you must analyze the international experience in the field of training in the field of nuclear energy leading countries. Based on the analysis criteria have been formulated to optimize the educational process of training specialists for the nuclear power industry and test their effectiveness. The most effective and promising is the introduction of modern information technologies of training of students, such as real-time simulators, electronic educational resources, etc.

1. Introduction
The High-tech sectors of the economy have already been formed, in particular, nuclear power complex, in which Russia claims the creation of competitive advantage in the medium term. The complexity of the technological generation process at nuclear power plants causes high demands on the skills of the workers that, in its turn, caused the rejection of the conversion to two-level system of training (bachelor and master) and maintaining the specialist degree.

According to the Concept long-term socially-economic development of the Russian Federation for the period until 2020, approved by decree of the Government of the Russian Federation, the Russian economy will remain a world leader in the energy sector and also create a competitive economy of knowledge and high technologies. This is why it's necessary to constantly improve the system of training highly qualified specialists.

To date, Russia is one of the leaders in the nuclear energy market. Already, Russian universities are training specialists in nuclear energy for a number of foreign countries (Vietnam, Egypt, China, etc.). To further enhance the competitiveness of universities in this area, it is necessary to take into account the experience of countries such as France, Japan and the USA [1].

2. World experience

2.1. France
For more than half a century, France has been training specialists for work at nuclear power plants. In France, the following modern developments are used to train personnel for nuclear energy [2]: training
centers with full-scale NPP training models, simulators of operating nuclear power plants, electronic free access courses and virtual reality tools.

2.2. Japan

In Japan, there are many universities that provide quality education in the field of nuclear technology. To study in universities of Japan come mainly from Asian countries: China, Korea, Thailand, Vietnam and Indonesia.

To prepare qualified personnel for nuclear power enterprises in Japan, the following measures are taken [3]:

1. Ancillary tools are being developed to accelerate on-the-job training (on-the-job training);
2. Improves the overall technical base, and introduces the Plan-Do-Check-Act (PDCA) cycle - a cyclical repetition of the decision-making process used in quality management.

2.3. United States

The leader in the amount of energy produced at nuclear power plants is the United States. Accordingly, much attention is paid to personnel training for nuclear power enterprises in this country. The number of US universities that train personnel for the nuclear industry is more than fifty. In America, to upgrade the level of skills and gain new knowledge to students from the US and other countries is offered through online programs. Online learning at first glance cannot be perceived without skepticism, but such programs are quite popular and in demand.

3. Optimization of training

Improvement of the learning process conditions should be considered not as a side issue, but as one of the most important organization principle of the learning process and especially its optimization.

"Optimal" from the Latin. "optimus" is the best. As for the optimization of teaching process, it is management, which is based on comprehensive considering of laws, principles of learning, modern forms and methods of training, as well as features of this system, its internal and external conditions in order to achieve the most efficient (within optimal) operation of the process in terms of a specified criteria.

Optimization of training is activity on the selection of content, forms, methods and conditions of training of competent engineering personnel. It performs the following functions [4]:

- Coordinating – organization of interaction of every party, which interested in quality;
- Dynamic – the transformation of very parties;
- Holistic – combination of the entire preparation process;
- Comparative-evaluative – the unity of such structural components as technological, dialogic and motivational.

Bespalko V.P. distinguishes 4 levels of training (table 1) [5]:

| Level          | Signs                          |
|----------------|--------------------------------|
| I (learning)   | knowledge-experience           |
|                | The ability of the student to  |
|                | identify, distinguish          |
|                | previously familiar object,    |
|                | phenomenon, certain            |
| II (reproduction) | knowledge of copy              |
|                | The ability to repeat, to      |
|                | reproduce the previously       |
|                | obtained training              |
| III (application) | knowledge-skills              |
|                | The ability to use previously  |
|                | acquired knowledge in solving  |
|                | practical problems             |

Table 1. Levels of training.
IV (creativity)  knowledge-transformation  The ability to transfer previously acquired knowledge to new, not previously studied tasks or problems

At the organization of educational process it is necessary to implement IV level of education. If it is so, the graduates will be able to implement their knowledge in practice the most effectively. And for this it is necessary to optimize the process of training specialists for high-tech enterprises of atomic energy.

One of the most important stipulations of efficiency increase of the learning process is to identify the optimal combination of the different training methods. Only integrated use of approaches will provide the most effective result of the goals and tasks achievement.

This raises the question of technologies and methods of training specialists for the nuclear power industry in the conditions of modernization of higher education system and changes in requirements to their qualifications.

4. Methods of education
For a long time the higher education system, based on the methods of traditional education, have been preparing professionals with strong theoretical knowledge. Today, however, has changed graduation requirements. After graduation students should possess a certain set of competencies. Their effective development is difficult in traditional learning, because competencies are multifaceted and complex in structure. Therefore, the higher education system of Russia shifted to a competence-based approach.

Approach – philosophical category, representing the base principles of persons, who are involved into the pedagogical process [6].

4.1. Competence-based approach
Competence-based approach is a priority orientation on the goal. Vectors of education: educability, self-determination, self-actualization, socialization and personality development.

The purpose of the competence-based approach to assure quality education, which is understood as a system of properties and characteristics, representing the compliance of the education with contemporary needs and values and also ideas about his future [7].

Also, the competence-based approach is seen as a way of learning that focuses on students mastering core competencies, which are universal for exploration of different types of activities, as well as requiring skills to use means adequate to the situation.

This approach is undoubtedly fundamental in the formation of students’ competencies in preparation for future work on high-tech enterprises of atomic energy.

4.2. Context-competence approach
The implementation of the competence-based approach requires essential changes at all levels of the educational system, and hence in itself as to the integrity: values, aims and learning outcomes; content; teacher; student activities; the technological support of the educational process; in educational environment; in relations with the external environment, etc.

A.A. Verbitsky offers a synthesis of the competence-based approach and the principles of contextual learning [8].

Learning is considered as contextual, if the subject and social content of professional work is dynamically modeled in the language of science with help of the entire system of traditional and new pedagogical technologies in the forms of educational activities, more and more approaching to the forms of professional activity. Thus, the conditions of transformation of student's educational activity in a professional activity are provided. In this study to overcome the main contradiction of professional education, which consists in the fact that mastering of the specialist's work must be ensured within the framework and by means of qualitatively different educational activities.
A.A. Verbitsky argues that synthesis of the competence-based approach and the principles of contextual learning may be a response to a number of requirements that apply to the reform of the education system, namely:

- to be recognized by scientific and pedagogical community;
- to have the necessary capacity in the understanding and explanation of a wide range of empirical data and facts;
- to provide forecasting capability, scientific rationale and productive implementation of practical steps to reform all of education based on the competence-based approach;
- "to grasp" in detail-technological (learning) and social-moral (education) aspects of students activities, achieving their training and education in one thread social educational activities;
- to have the property of adaptability, through its "glasses" were viewed the specific ways of design and implementation of innovative educational process.

Capabilities of the context-competence approach to organization of educational process of training specialists is considerably expanded in comparison with the competence-based. Therefore, this approach is appropriate for optimizing the process of training specialists for high-tech enterprises of nuclear energy.

4.3. Activity approach

The formation of professional competence, as well as components of the professional culture is effectively on the assumption of the implementation of the activity approach to process of training. The idea, which is the basis of the activity approach in teaching, was formulated by S.L. Rubinstein [9], and the concept of "teaching through activity" was first proposed by American scientist J. Dewey.

The activity approach is a process of human activity aimed at the formation of his consciousness and his personality in general. This approach is widespread in teaching students of technical universities, because the process of developing a qualified specialist means a consistent mastering professional activities.

At implementing this approach, it is necessary to pay more attention to carrying out practical and laboratory works, and study of theoretical material should be individual (based on e-learning course). The solution of practical professional tasks in the course of laboratory works on a unique modern equipment, will promote the development of students’ professional competencies.

The use of this approach will improve the competitiveness of graduates in the labour market, because they will have an extensive set of practice-oriented professional competencies and not just an extensive set of theoretical knowledge in the field of nuclear energy.

4.4. Student-centered approach

Another important approach, which helps to optimize the training of specialists for high-tech enterprises of nuclear energy, is student-centered one.

The work of each professionally-official groups in nuclear power plants has specific requirements for the executor's personality, this is why, consideration of individual deviations helps reduce the number of violations.

For the successful professional training of specialists it is necessary to create conditions with elements of developmental education, one of which is based on individual features.

Considering the individual characteristics (aptitudes) contributes to the humanization of the learning process and the development of personal potential, which is characterized by different abilities: cognitive, intellectual, communicative, artistic and creative.

Student-centered educational technology, which was developed by I.S. Yakimanskaya [10], aimed at creating conditions for the realization and enrichment of the subjective experience of the student, of the life-experience, where he reveals and develops as a subject of knowledge (the teachings), as an individual.
The formation of the creative personality – the purpose of innovative education. The humanistic approach requires an individual one to each student, and recognition of his uniqueness.

Younger generation has significant potential, the development of which is hampered for a number of reasons. One of them is a disregard for the individual aptitudes of schoolchildren, students for presentive, professional activities. It is greatly reducing the quality of their training.

The main issue of the teacher at implementing a student-centered approach is to help the student in its maximum artistic development through awareness, perception, motivation to self-exploration, to experimenting with using a variety of means, assistance in realization of individual style of educational activity, development of theoretical thinking and reflective action.

5. Modern technologies
The organization of the educational process of training specialists for nuclear power enterprises was carried out by integrating modern information technologies into the existing educational process. For this, both profile software - DYNCO LAB, developed in Obninsk, and the free learning environment LMS MOODLE was used.

LMS MOODLE (Modular Object-Oriented Dynamic Learning Environment) is a course management system, also known as Learning Management System (LMS). The convenience of the environment is due to a wide range of functionality: integration of data from various external sources, extensive internal editing capabilities (built-in HTML editor), the creation of automated control materials (tests, tasks) [11, 12], the availability of means of communication (chat rooms, forums), Monitoring of the educational process, etc.

The problem of implementing this system is that not every teacher is able to understand such a large set of functional possibilities and as a result competently and efficiently organize the educational process.

The profile software DYNCO LAB, is intended for carrying out works aimed at studying transients in nuclear power reactors. Thanks to this complex, everyone can master the competencies necessary to control the reactor, without threat to themselves and others. It is very important that it is possible to regulate the rate of transient processes. Due to this, it is possible, for example, to launch a nuclear reactor in one class, which in practice is not possible.

6. Conclusion
On the basis of conducted analysis of different approaches to organization of educational process have been formulated following criteria to optimize the preparation of students for professional activities of high-tech enterprises in the nuclear power industry:

1. Formulation of goals and learning outcomes-based educational standards, the requirements of employers and individual aptitudes of students.
2. The maximum possible (under existing conditions) the development of professional competences in the learning process.
3. Minimal effort, effort and time to achieve the planned goals and learning outcomes through the use of information technology and modern equipment.
4. Integrated use of context-competence, activity and student-centered approaches on the basis of modern educational technologies.

The implementation of the educational process, taking into account the identified optimization criteria, will significantly improve the effectiveness of the learning process, and more effectively realize the potential capabilities of students form and develop the required list of competencies.

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