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Prospective systems and training models

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***Abstract*— The article provides an overview of modern models that are effectively used in the educational process. We define the key parameters for the comparison of training models of the in-demand staff. It identifies a number of traditional basic models (British, Spanish-French, German, Scandinavian). It describes the CDIO approach, the ABET dual-loop model, and the dual system of education that are effectively used in world education. The essential characteristics of the modern model of vocational education are revealed.**

Keywords - model, system, education, CDIO approach, ABET dual-loop model, dual education system, specialists PDA, training

I. Introduction

The assessment of the current situation on the educational services market notes that Russia is not inferior to the leading countries of the world in the number of scientists and engineers, in the number of research higher educational institutions. At the same time, the quality level of training professionals lags far behind due to the lack of funding for science, the underdevelopment of the scientific infrastructure and the poor support of the educational process with modern technologies. Analytical awareness of educational models of students in Russia and abroad define the prospects and transformations necessary for the transition to innovative models of staff training demanded in PDA zones.

II. Materials and Methods (Model)

The key parameters for the comparison of training models of the in-demand staff are the following:

- education management;
- system characteristics and structural organizations;
- an intensive process of vocational training (priorities and focus trends);
- the specificity of the socio-psychological interaction of educational institutions with education stakeholders and consumers of educational services represented by social institutions and industrial enterprises;
- criteria for evaluation of the quality of future staff training in the framework of ASIIN accreditation, ECUK and AEER requirements, EUR-ACE standards [1, 2, 3].

In the study of the models of students` professional training according to the specified criteria, the correct formulation of possible measurements ranges is especially significant:

- management of education (as characteristics of the model, we can highlight the powers relations, including sectoral and public administration; delegation of authority to regional bodies, business structures; the self-sustainment level of the educational institution; distribution of administrative (organizational, control, financial) functions of management entities);
- system characteristics and structural organizations (the structure of education system as a whole, the temporal characteristics of training, stages, levels, forms of organization of vocational training and further vocational education, completeness of education, etc. are studied);
- content basis of vocational training (it is necessary to analyse educational programs, curriculums and work plans, educational priorities, etc.);
- specific features of social interaction (it is supposed to consider the admission arrangements of students at educational institutions, the forms of relations between educational institutions and business structures, the modalities of cooperation, its tasks, mechanisms to ensure conditions to address them) [4, 5].

The above criteria for the main characteristics of the education system are formed historically to take account of developments in socio-economic processes. The main basic training models of in-demand staff are also historically formed. Traditionally, researchers have identified the following basic models:

- British;
- Spanish-French;
- German;

- Scandinavian.

All of them have characteristic features in the students training system, education management, substantial and structural characteristics of education.

One option for the division of training models may be its structure and composition of components. Our analysis resulted in the identification of four groups of training models in Russia and abroad.

1. Models of the first degree are called regional (organizational). They include all kinds of professional educational (Primary vocational, secondary vocational, further vocational and higher education) and other organizations, enterprises, institutions, associations for implementation of the training staff tasks for the needs of their region.

2. Models of the second degree are called sectoral. They include elements according to the principle of “first sectoral and then regional societies,” consisting professional organizations of all levels of education, which at the same time retain their autonomy.

3. Models of the third degree are called institutional (structural). They unite all the elements, namely before vocational, vocational and post-vocational education, which are part of the educational institution.

4. Models of the fourth degree are called functional (at the level of the implementation of educational programs). They include various types of educational programs, as well as technologies for their implementation.

The prospect of a modern model of education is multistage training. The search for the most optimal organizational requirements for the implementation of a multi-stage model of education in the practice of national education is confirmed by scientific works in the field of vocational education of authors such as M.G. Minin, Yu.P. Pokholkov, G.V. Mukhametzyanova, A.I. Chuchalin, as well as the growing number of publications on this issue by authors such as V.N. Mikhelkevich, V.A. Gusev, A.N. Bekrenev, E.L. Osorgin, Y.A. Kustov [6, 7, 8, 9, 10]. The most relevant area of research is the analysis and evaluation of the implementation of a multi-stage training model in all countries of the world, which is studied by such authors as E.E. Islamov, L.I. Solomko, L.I. Solomko, L.I. Matushansky, K.S. Makhmuryan [11, 12, 13]. Currently, the transition to a multi-stage model of higher professional education in Russia expresses global integrated processes. The integration of Russian education into the framework of the European educational space determined changes in the structure of training [14, 15]. The model of adaptive staff training is becoming widely sought-after for various sectors of the country's economy and, in particular, for PDA zones.

The implementation of the specifics of multi-stage education brings the diversity of training models for the in-demand staff. Thus, the more levels and stages of vocational education, which is supported by relevant documentation, the more the model provides the diversity of individual pathways of the learning process. The principle of educational agility is widespread, that facilitate the organization of diverse linkages within the system.

The study of foreign experience in the implementation of multi-stage education gives the right to talk about a high degree of diversification of general, primary and secondary vocational education. The research of the American education system showed that, on the one hand, it is based on a variety of forms of secondary education, while on the other hand, the structure of the American university can include "up to ten different colleges." The latter adds versatility to the educational institution [16].

It is the versatility of the professional educational institution that turns out to be another significant aspect of the modern stage of development of higher education. Therefore, it arguably among the main characteristics of the modern education model.

The CDIO approach is actively used and introduced in many American universities. It is aimed at training and comprehensive education of staff who are able and willing to design, plan, predict, produce and use complex objects, systems and processes with high added value in the current teamwork environment. This approach seeks to implement three general objectives of graduate training, as a result of which future specialists will be able and ready to[17]:

- apply basic knowledge in practical activities,
- manage the process of creating and operating engineering facilities, processes and systems,
- understand the importance and the effect of scientific and technological progress on society.

Education based on the CDIO approach is formed on the construction of significant technical knowledge in the context of design, planning, prediction, production and use of objects, processes and systems. This approach seeks to create the most effective educational programs that will interest students and will be able to attract them to the educational process, retain them in the chosen direction and in the profession.

Design, planning, prediction, production and use should be perceived as a context, and not as a subject of education. The educational context is a field that promotes understanding, comprehension and acquiring new knowledge and skills. The selection of the design, planning, prediction, production and use as an educational context should correspond to the professional activity of a specialist and form the natural conditions for the acquisition of the main competencies. The educational context influences the formation of an integrated approach to the designation of the educational needs of students and the development of a consistent relationship between all educational activities that address these needs [18].

Within the CDIO approach, special attention is paid to the ABET Accreditation Council for Engineering Education in the United States and dual-loop ABET model is used strongly in assessing the development of due competencies as a result of specialist training [19].

The use of ABET in the process of training of staff in-demand on PDA, is implemented using a dual-loop model requiring a specific sequence of all design stages and quality assessment of educational programs that are used in the process of training and competency determination, and also

establish the relationship between the internal university educational processes and the external environment (fig.1) [20].

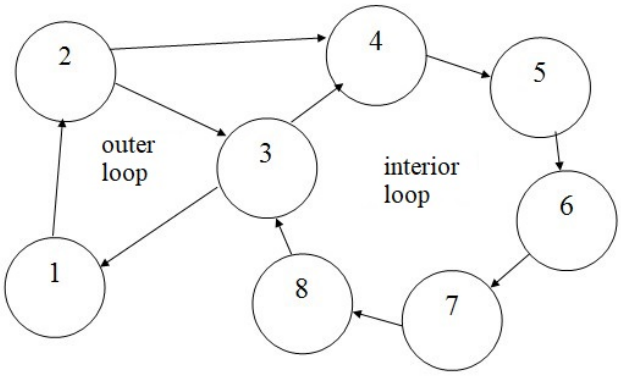

Fig. 1. Dual-loop competency ABET model

In fig.1 you can see the following steps: 1 - training requirements of stakeholders, 2 - formation of training program objectives, 3 - verification of the achievement of program objectives through the evaluation of training results, 4 - planning of the required learning outcomes to achieve the objectives of the program, 5 - determining how results will be obtained, 6 - determining how the results will be assessed, 7 - defining indicators for obtaining results to achieve the objectives, 8 - organization the educational process.

The dual-loop model, namely, its external loop, shows that the requirements of stakeholders act as input data for the formation of educational program objectives, which are transformed into planned learning outcomes, which are further evaluated by means of a comparative analysis with specified parameters. The internal loop of the dual-loop model demonstrates the sequence of planning achievements and evaluating the learning outcomes obtained, during which the objectives of the educational program in any educational institution are tested.

When analysing vocational education in Germany, we elaborated on the Dual System of Education, which has been effectively used in training for many years. The dual system is effectively implemented in many countries of Europe and the CIS, including Russia.

Along with full-time education, which is the main form of employment in the development of undergraduate and graduate educational programs, other forms of education appear in modern Germany, involving a large degree of flexibility temporary (external studies, on-the-job training) and spatial (distance learning). In addition, in German universities every year, other teaching formats that differ from generally accepted standards are increasingly used, for example, international educational programs and dual education. As a rule, such forms of education are more common in higher vocational schools, and private universities are increasingly using on-the-job learning opportunities and distance learning. Although the proportion of students of distance studies remains negligible compared to traditional full-time studies, only 4% of all applicants choose this form of education.

Based on a combination of vocational education in a specialized enterprise with theoretical studies in a higher educational institution of a corresponding profile the dual form of education is gradually gaining popularity, and the number of educational programs implemented in this form is increasing. Upon completion of such an educational program, a graduate not only receives a bachelor's degree but also obtains a certificate of professional training at the same time. At present, about 1000 such educational programs are being implemented in Germany.

The dual vocational training system is an important part of the general education system in Germany. The system of vocational training is closely connected with the economic and social infrastructure of the country and cannot be blindly transferred to the educational systems of other countries [21].

German experience has shown that the dual system of vocational training can serve as an interesting example for other countries.

All the above models provide for the presence of substructures other than the traditional ones. Thus, educational, scientific and innovative complexes include not only special educational structural divisions but also a research university, an innovation complex, which is also provided for in an innovation university. The educational organizational structure in the complex implies departments, faculties (institutes), specialized lyceum classes, vocational-technical schools that allow performing a permanent multi-level, multi-stage education. The academic structure includes a developed system of pre-university training of applicants, ensuring an effective level of their readiness, based on special educational programs in the system of continuing education “school – university”. The high standards of the level of knowledge, of the level of social, psychological and intellectual development are necessary for the formation of special selection criteria. This system also involves the work of a one-year college that prepares students from other universities who wish to continue their studies at the basic or postgraduate level of a university. In this case, the emphasis is on international relations in an educational institution [22].

III. Results and Discussion

Summarizing the above, we can underline the main important characteristics of the modern system of staff training. Today both Russian education models and foreign ones apply them in practice (fig. 2).

Contrary to the presence of joint characteristics in the modern model of vocational education, expressing the socio-historical degree of development, the individual factors of the creation remain the fundamentals elements of the model, one way or another streamlining the activities of the educational institution. Despite the democratic processes taking place in our society, the state still plays one of the important roles in education, based on the state monopoly issuance of the document.

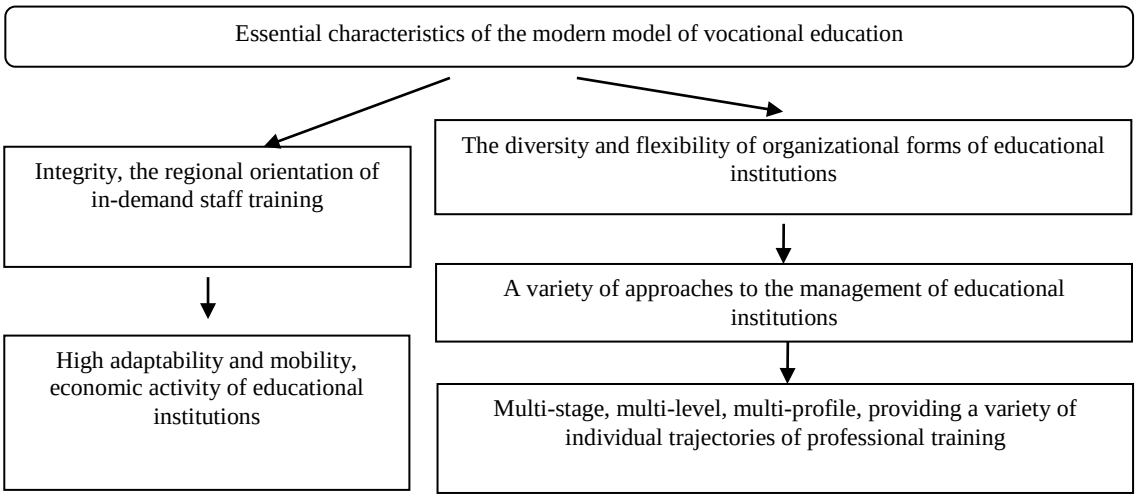

Fig. 2. Essential characteristics of a modern training system

In her scientific works G.V. Mukhametzyanova pays great attention to the statehood of education in the conditions of the functioning and development of education. Based on this principle, the state is responsible for the quality of education, the dynamic growth of the population`s level of education, the financing of scientific activities of educational institutions. It guarantees the unity of the educational space, develops educational standards and mitigates educational risks for the population. Today, the activity of state assistance in the training of highly specialized human resources is also expressed in the regulation of individual advancements in the field of education. Therefore, there is a unified state exam, which establishes benefits for certain categories of citizens, develops educational standards, and various quotas for the financing of educational institutions. These and other forms of state assistance in the activities of educational institutions are specific features of the Russian model of vocational education.

That is why one of the relevant tasks of this work is the study of the prospects for the development of a modern model of vocational training in the context of state education management, the possibility of social partnership in creation of flexible model of vocational training for staff of different levels of vocational education for the needs of an innovative economy.

Modern technical education is becoming a significant area of educational activity [23]. At the same time, the peculiarity of the future profession of engineers, capable and ready to meet the requirements of an innovative economy, shows follows needs for educational institutions:

- increased attention of educational institutions to the formation of a technological culture of future professionals;

- improvement of the level of practical experience that impacts on the result of professional formation of a specialist;

- awareness of students about the features of the modern production process, the main problems, new directions and prospects for its further development;

- creating a culture of innovation and production activities and analysis of the primary experience of its implementation.

IV. Conclusion

In the course of the analysis of modern scientific literature on professional training and research on the practical experience of reform of Russian education, the following conclusions were made: Despite certain differences in modern models of vocational education, they all have some common features, such as multi-stage, multi-level, multidisciplinary, diverse and flexible forms of education. The emergence of these indicators gives the individual the possibility of free movement in the educational space, thus space itself ceases to be finite, which is called “education through the whole life”. The main feature of the Russian model of vocational education is the large role of the state in regulating educational interaction.

Educational institutions training staff of a diverse professional level of education for production and technical organizations, in providing various training situations, are aimed at optimizing the use of internal and external resources necessary to improve technical training of personnel.

Considering the regional level, it is clear that the following characteristic features of educational models are promising: strategic management, integrated methodological centre, resource approach, giving effect to social cooperation necessary for staff training. Considering the sectoral level, it is clear that the priority formation of vocational education, necessary for the supply of modern and future needs of a particular industry, the planning of relations between educational institutions and enterprises, various forms of relationships and associations of education and production are of particular importance.

Considering the level of the educational institution it is clear there occur diversification of all types of activities and emergence of the relevant new structural units of the matrix type; emergence and diversification of various types of integrative vocational education institutions; focus on strategic development goals. Considering the level of

implementation of educational programs, we find the significance of the ability to perform educational programs of different levels and specializations; increasing the graduates' competencies through the introduction of additional educational programs; performance of individual educational pathways [24, 25].

The above-distinguished characteristics of different models are not contradictory and can find their application in the development of a training model necessary for industrial organizations in the region.

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