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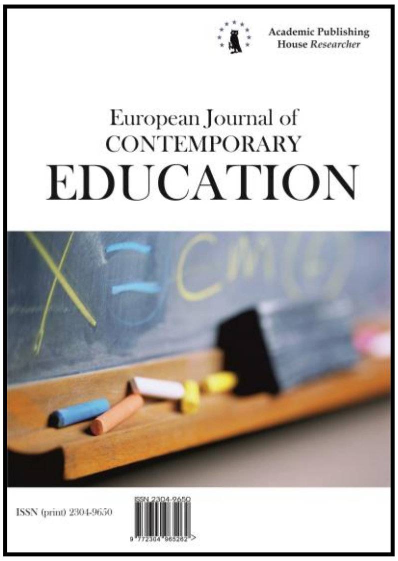

Specific Features of Vocational Education and Training of Engineering Personnel for High-Tech Businesses

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Abstract

The article outlines the main approaches (person-centered, systemic, competency-based and integrative) in vocational education and training of engineering personnel for high-tech industries based on the analysis of academic research and practical experience. Vocational training of engineering personnel for high-tech businesses should be conducted in accordance with the professional requirements, while keeping professional standards, competencies, skills and qualifications in sharp focus to ensure successful and efficient job performance.

The conducted research showed that the level of professional competence of engineering students is insufficient. The important personal attributes of an engineer are as follows: ability to work in a team, work initiative, competence, ability to learn fast, responsibility, good communication skills, stress resistance, leadership qualities, commitment to professional development. The vocational training of engineers in the academic setting should be a system of organizational and teaching activities that should enable the graduates to be professionally ready for their future job.

Keywords: vocational education, engineering education, engineering personnel, educational standards, professional development, students, training, personal and professional approach, system, competence, integration.

1. Introduction

Nowadays, the countries that are able to make breakthrough advances and expand them into the modern technological base have become the leaders of the global development process. The training of engineering personnel is one of the underlying factors of the country's global competitiveness and serves as a basis for its social and economic development. Russia's ongoing transition to an innovation-based economy, the development of modern information technology,

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the creation of human-machine systems have been determining current engineering in a new way. There has been a growing need in our country for new engineering personnel ready to actively participate in innovative processes and solve professional engineering tasks (Strategiya…).

It is impossible to implement an innovative society-oriented model in Russia without developing an adequate system of vocational education for engineering personnel. The system of vocational education should be based on the Federal State Educational Standards for Higher Education in the relevant fields of study and requirements from the employers, meaning the vocational standards that came into effect on January 1, 2017. They are based on the requirements for the engineer's qualifications and include job functions, job activities, special skills and level of knowledge (Professional standards).

In recent years, the Ministry of Education and Science of Russia has increased funding the admission to higher education institutions for applicants to the technical degree programs at the expense of state budget. Technical degrees are once again becoming more popular among the applicants. However, despite the measures taken, the demand for engineering personnel is not fully met, both in numbers and quality. Every day the development of all industrial sectors and communication sector places new demands on the level of engineers' vocational education. Nowadays, the emerging innovation-based economy in Russia requires highly skilled professionals with creative and innovative potential.

In our opinion, a system of vocational engineering education that would teach future engineers in high-tech industries to anticipate the potential issues and adapt accordingly is the key to solving this problem.

Amurskaya Oblast has an important geopolitical significance and a remarkable potential in terms of natural resources. The support of the federal center has attracted here large-scale projects, with many of them being actively implemented at the moment. To name a few key investment projects – the commissioning of the ground-based space infrastructure facilities of the Vostochny spaceport (Svobodnensky district), the construction of the "Power of Siberia" gas trunkline with technical support services, the construction of the largest gas processing complex in Russia (Gazprom, city of Svobodny) and the gas chemical plant (SIBUR, city of Svobodny), the construction of a production plant for the cement clinker (Berezovka village), the construction of a motorway bridge between the Russian Federation and the People's Republic of China in the city of Blagoveshchensk, commissioning Nizhne-Bureyskaya Hydro Power Plant etc. (Plutenko, 2017).

High-tech industries include aerospace industry, tool engineering, microbiology, nanotechnology, power industry, IT, etc. Vocational training of engineering personnel for those industries requires the systematization of modern approaches to the academic training at the university.

The high-tech companies located in Amurskaya Oblast include the Vostochny spaceport – the first civilian spaceport in Russia, the Bureyskaya and Nizhne-Bureyskaya HPPs, gas processing plants, etc.

In order to operate properly, those companies require highly qualified specialists – next generation of engineers who are able to introduce and execute new ideas, develop projects with cutting edge technology and new types of equipment, those who demonstrate modern knowledge and practical engineering skills and capable of continually improving their professional level.

At the Amur State University we provide vocational education and training for the engineering personnel for our strategic partner – the Center for Ground-Based Space Infrastructure Operation (FSUE "TsENKI") – in order to complete the Vostochny spaceport project in Amurskaya Oblast. TsENKI is one of the key enterprises in the aerospace industry. The company specializes in creating a ground-based space infrastructure and manages the spaceports of Russia.

Close cooperation between the university and the spaceport on the personnel training should be considered as one of the main ways to improve the quality of education, provide practice-oriented training for the specialists, and create an environment for innovation at the university and at the spaceport itself.

In 2016, the AmSU together with the TsENKI established the academic department at the Faculty of Engineering and Physical Sciences – "Ground-Space Infrastructure Facilities Operation".

At present, the Amur State University provides education and training of engineering personnel for the Vostochny spaceport in the following fields of study within the academic majors:

1) "Maintenance and operation of technological equipment and power supply systems for the rocket launch site" within the academic major 13.03.02 "Electric Power Engineering and Electrical Engineering";

2) "Software and hardware for the data acquisition/processing system at the infrastructure facilities of the Vostochny spaceport" within the academic major 09.03.01"Informatics and Computer Technology";

3) "Workplace safety during the operation of the launch and technical complexes of the spaceport" within the academic major 20.03.01 "Technosphere Security".

However, there seems to be a lack of updated concept of engineering education, focusing on the management and training of engineering personnel for high-tech businesses.

2. Materials and methods

In our study into the ways of creating an academic system aimed at training the engineering personnel for high-tech business at the university setting, we used the following methods: systematization and generalization, concepts and facts, education models, analysis of the federal state educational standards for higher education in engineering majors and of the professional standards.

The purpose of the study was to determine the specific features of the vocational education and training of engineering personnel for high-tech businesses.

For the purpose of the study, a sociological study was conducted on the premises of the Amur State University. The experimental sample of 50 people was composed of engineering students from the Faculty of Power Engineering, the Faculty of Engineering and Physical Sciences and the Faculty of Mathematics and Computer Science.

We developed a questionnaire that included four parts:

1) general questions;

2) evaluation of the level of professional competencies;

3) evaluation of the quality of educational services;

4) final questions.

The list of professional engineering competencies used in the questionnaire is specified for each academic major in accordance with their educational standard, meaning that a separate questionnaire was developed for each major. The questionnaire was evaluated and approved by the experts: employers and leading professors. It was conducted among students, immediately after they passed on-site (pre-diploma) practical training at the Vostochny spaceport.

The received data were mathematically processed. The following measures of variation statistics were used for data analysis: simple average (M), quadratic (standard) deviation (σ), standard error of the mean (m), variation coefficient (υ), 95% confidence interval for the mean (M±m).

Student t-test was defined by the table with limit values, statistically significant probability level of 95, 99, 99,9%, and degrees of freedom $f = n - 1$.

3. Results

The analysis of the academic research showed that a number of studies are devoted to the problems of academic education and training of an engineer: A.A. Aleksandrov, I.B. Fedorov, V.E. Medvedev, L.M. Mitin, E.F. Crawley etc. considered the professional development of the engineer's career; E.B. Tkachenko, N.K. Chapaev etc. focused on theoretical aspects of education and teaching methodology; B.S. Gershunsky, D.A. Voloshin, A.A. Kirsanova, V.G. and Y.G. Tatur etc. were concerned with the content of vocational education programs; N.S. Glukhanyuk, E.V. Dyachenko, E.A. Klimov, A.K. Markova and others examined patterns and specifics of becoming an engineer.

Based on the theoretical analysis of the academic research, we have outlined the following approaches to the vocational education and training of engineering personnel for high-tech businesses.

1. The person-centered approach

In the vocational training of engineering personnel, the person-centered approach is applied to direct students towards self-study (their own discoveries, project work, etc.). It is important to stimulate students' work taking into account their abilities and personal inclinations (the choice of report topics, choice of the practice site, etc.); to provide a choice between team work and independent work; to allow students to evaluate their own answers by themselves, and then by the instructor; to practice use of individually-tailored assignments (Obshchaya…). For example, during the on-site practical training power engineers have to calculate the short-circuit currents in networks up to 1000 V, or to estimate reliability and maintainability of technical elements and systems based on the results of tests and observations, to analyze the reliability of local engineering (manufacturing) systems, to construct local engineering systems with specified reliability parameters.

Vocational training programs for engineering students should give particular attention to the development of those unique personal qualities that will be required in the professional setting – mindfulness, discipline, result orientation, responsibility, self-organization, independence, technical thinking, ability to concentrate, even-temperedness, perseverance, and tenacity.

Thus, a person-centered approach, relying on the fact that the personality is the combination of characteristics that form an individual's distinctive character, embodies an important psychological-educational principle of the individual approach, according to which in the process of vocational engineering training takes into account the individual characteristics of each student.

2. Systemic approach

Drawing on the general systems theory, we can pinpoint some essential features:

a) system is a combination of interrelated and interdependent parts;

b) system is a part (subsystem) of objective reality, one of its objects; any system does not exist by itself, it always functions and develops in a certain environment;

c) system has integrity, while its components are diverse;

d) each system has the ingrained mechanism for self-protection, self-dynamics and self-development;

e) system is always internally organized;

f) in terms of the level of development, the systems can be subdivided into highly complex, medium- and underdeveloped, elementary (Bertalanfi, 1969).

Engineering is a living system, so it can be considered within the framework of a systemic approach. An effective solution to the engineering task can be reached only on the basis of a comprehensive, holistic review of the system being developed and its enhancement in interaction with the environment. Only such systemic approach can result in truly creative and innovative solutions, including complex scientific inventions and discoveries.

A systemic approach to creativity enables the engineer to apply scientific methods when imagination and experience are not enough. This approach is a prerequisite for inventive activity and effective design and construction, and also allows engineers to withdraw from outdated traditions and patterns.

Progressively crucial role of the human factor in various spheres of life and social activities accounts for the increased requirements for the engineers' professionalism level. There has been a high widespread demand for highly qualified engineers capable of creatively solving complex problems, predicting and achieving the results in their own work, searching for ways and means of self-actualization and self-assertion while working independently. Many researchers note that the engineering students demonstrate the low level of aptitude for the creative approach to their professional functions or for the non-standard solution of manufacturing issues (Pedagogika…).

The solution to this problem seems to lie in the application of a systemic approach to students' academic and project work. Underestimation of the scientific approach to the vocational education and training as well as shortcomings in the engineering students' aptitude for professional activities lead to the conclusion that the potential of scientific research is still not fully utilized in the vocational training of engineers.

Students' participation in project work involves different tasks: design, planning, management, coordination of human and material resources throughout the project cycle. For instance, students majoring in "Aerospace Engineering and Astronautics" (24.03.01) are involved in the project on creating a nanosatellite since their first academic year. As a part of the project work, students determine the scope of work, task types, project costs and expenses, time parameters, including the terms, duration and slack time, the project stages, the coupling, resources required for the implementation of the project.

The implementation of the systemic approach happens in stages. Academic work with students within the framework of vocational training attaches great importance to motivational, diagnostic, projective, practical, reflexive and corrective stages.

The implementation of the systemic approach in the vocational training of engineering personnel requires a step-by-step solution of the following tasks:

1) developing the project concept, creating a resource, academic and methodological base;

2) setting timetable of academic work in accordance with the specifics of the faculty and the framework of the educational process;

3) providing the students with a competent academic advisor;

4) involving students into academic and research work, taking into account their aptitude level and research work experience;

5) involving leading employers and practitioners into the educational process;

6) organizing and conducting on-site practical training in high-tech businesses.

Thus, all components of the students' academic and research work comprise a complex and interrelated process, which effectiveness is determined by the systemic approach to its organization.

3. Competency-based approach

There are two approaches to understanding key competencies. Personal qualities are referred to as key competencies, which are important for a career in a number of diverse professions (emphasis is placed on personality). According to V.I. Bidenko, the term "competence" is used to indicate integral characteristics of the quality of graduate's training, the category of education outcome. Thus, competence is a new type of goal setting. This should signify the shift from predominantly academic assessment standards to an external evaluation of the professional and social efficiency of graduates (with a focus on graduates' market value). Other researchers describe them as "cross-cutting" knowledge and skills required in any professional activity, in different types of work (emphasis is placed on broad knowledge and skills) (Novikov, 2010).

In Russian science, the research within the framework of the competency-based approach mainly revolves around the connection between the competence and content of education. Therefore, the competent engineers differ from the qualified engineers in that they possess not only knowledge and certain level skills, but they are also capable and prepared to utilize them in engineering. It is important to mention that competence suggests that engineers are intrinsically motivated to perform their professional tasks at a high quality level, as well as to demonstrate their professional beliefs and principles and value their profession.

4. Integrative approach

In this study we consider the integrative approach from the point of mutual integration between vocational engineering training theory and its practice.

The use of an integrative approach in the engineering training and education curriculum is currently becoming a paramount objective aimed at improving the quality of vocational education.

By integration in the engineering training curriculum, we understand the connection, the concurrence between academic and professional tasks within the specific disciplines, the expansion of interdisciplinary ties, the controlled deepening of the content of general, industry-specific and vocational disciplines. Integration processes are seen not in terms of generalization and accumulation, but in terms of dynamics and integrity.

Integration is based on the following principles: comprehensive planning of the most important training tasks, personality development, enhancement of educational and cognitive activity, development of students' basic competencies, including research skills. This integration can be seen as a two-way process - external and internal. External integration is necessary to eliminate duplication in the disciplines' content, and to provide consistency and synchronization in the instruction tasks, as well as justified deepening of the content at the level of industry-specific education. Internal integration is a process of learning, based on the optimal choice of general education principles, methods, rules and means of teaching.

The purpose of the interdisciplinary integrative approach to vocational training curriculum is to ensure the systematic character of theoretical knowledge and the comprehension of complex phenomena and processes of social and professional reality, the development of a holistic view of a particular discipline, phenomenon, and activity. The approach is implemented by organizing the information (scientific concepts, laws, data, etc.) from different academic disciplines around the common discipline (integration core). The number of those disciplines' topical issues is considered from the point of view of the object, subject and the aims of an integration core discipline, meaning the discipline which either initially or essentially provides the definition of the integrative approach subject (Novikov, 2010). For example, when developing engineers' professional competencies within the academic major "Aerospace Engineering and Astronautics" (24.03.01), the "Design and construction of aircraft" can become the integration core discipline, etc.

It should be noted that an integrative approach to the engineering training involves the modernization of curriculum based on external integration, which leads to an interdisciplinary connection (the development of integrative systems), to the planning of course curriculum on the basis of topic blocks and to a certain choice of methods, techniques, means of training with a combination of frontal, group and individual forms of training (internal integration). This contributes to training synchronization, removes unnecessary workload of students, and eliminates the fragmentation of knowledge, allowing us to achieve greater concentration of students' attention and immersion in the material.

One of the aims of this research was to study the professional competencies development in engineering students who were taking their on-site practical training at the Vostochny spaceport.

During the on-site practical training at the Vostochny spaceport, 47 % of the respondents indicated that most of the skills obtained in the training course at the university (general and vocational) were useful for professional development. However, there was a lack of certain professional skills, which is why students needed serious additional training. 41 % of respondents required minimal additional training, and all their skills (general and professional) were very useful for professional development. Only 6 % noted a significant lack of professional skills during their practical training at the Vostochny spaceport. Another 6 % of respondents were undecided.

The respondents were asked to identify the most important professional competencies and on a 10-point scale indicate the degree of their development (Table 1).

The list of professional competencies in the academic major 09.03.01 "Information Science and Information Technology" includes eight competencies. 60 % of respondents identified the two most important: "Developing hardware and software components of systems and databases with the use of modern technological solutions and software tools" and "Connecting and configuring computer modules and peripheral equipment." The mean value for all competencies is 6.4.

Table 1. Assessment of the professional competencies development (academic major 09.03.01 "Information Science and Information Technology")

No.	Professional competences	Mean value	Standard error of the mean
1	Connecting and configuring computer modules and peripheral equipment (PC-6).	7,8	0,4
2	Providing interface between hardware and software in the information processing system and automated systems (PC-5).	7	0,5
3	Justifying the choice of design solutions, designing and conducting experiments to assess their performance and efficiency (PC-3).	6,6	0,6
4	Preparing materials and organizing training necessary for technicians and workers so the organization has the capacity to effectively operate and maintain engineered systems and works (PC-4).	6,6	0,9
5	Developing models of information systems components, including database models and human-computer interface (PC-1).	6,2	0,8
6	Monitoring the equipment's technical condition and performing the preventive maintenance (PC-7).	6	1,26
7	Developing hardware and software components of systems and databases with the use of modern technological solutions and software tools (PC-2).	5,6	0,2

No.	Professional competences	Mean value	Standard error of the mean
8	Creating operating manuals (PC-8).	5,6	1,53

Thus, according to the respondents' opinion, their level of the competencies development is satisfactory. However, respondents also pointed out that one of the most important competencies (PC-2) showed a low level of development.

Also, the low level of competence development in terms of PC-7 and PC-8 can be attributed to their absence in the curriculum for this major.

The list of professional competencies for the academic major 20.03.01 "Technosphere Security Policies" comprises twenty-two items. 60 % of the respondents noted the importance of such a professional competence as "Applying existing relevant local and federal laws and regulations to ensure the security of assets to be protected" in order to efficiently accomplish their work. 50 % of the respondents identified the competence "Applying regulatory requirements pertinent to workplace safety, environmental safety, and safety in emergency situations" as a particularly important one.

Table 2 shows the level of professional competencies development.

Table 2. Assessment of the professional competencies development (academic major 20.03.01 "Technosphere Security")

No.	Professional competences	Mean value	Standard error of the mean
1	Determining the regulatory levels of permissible negative impacts on individuals and the environment (PC-14).	8,5	0,5
2	Knowing the basic methods and systems of providing technosphere security, and justifying the choice of known devices, systems and methods for protecting individuals and environment from hazards (PC-5).	7,8	0,3
3	Applying the skills of conducting and interpreting research and experiments (PC-23).	7,8	0,6
4	Measuring hazard levels in the environment, processing the obtained data, predicting the possible development of the situation (PC-15).	7,6	0,4
5	Analyzing the effect mechanisms of hazards on individuals, identifying the nature of the interaction between the individuals and the environmental hazards, taking into account the specific mechanism of toxic effects of harmful substances, energy impact and combined impact of hazardous factors (PK-16).	7,6	0,5
6	Staying well-informed about the main issues of technosphere security (PC-19).	7,5	0,6
7	Organizing, planning and performing the work tasks aimed at ensuring safety for both individuals and the environment (PC-11).	7,3	0,5
8	Applying existing relevant local and federal laws and regulations to ensure the security of assets to be protected (PC-12).	7,3	0,6
9	Performing safety checks on objects of various purposes, participating in the safety evaluation of those objects, regulated by the current legislation of the Russian Federation (PC-18).	7,2	0,4
10	Solving engineering issues as a part of the research team (PC-21).	7,2	0,2
11	Applying the laws and methods of mathematics, natural science, humanities and economics to solve engineering issues (PC-22).	7,2	0,5

No.	Professional competences	Mean value	Standard error of the mean
12	Developing and using graphic documentation (PC-2).	7	0,5
13	Assessing the risk and determining security measures for the technology being developed (PC-3).	6,7	0,8
14	Applying regulatory requirements pertinent to workplace safety, environmental safety, and safety in emergency situations (PC-9).	6,7	0,8
15	Participating in research and development in the relevant fields: systematizing information on the research topic, participating in experiments, processing the obtained data (PK-20).	6,7	0,8
16	Being able to substitute certain workers or employees and perform their work (PC-8).	6,5	0,6
17	Participating in engineering projects on the average level of complexity as a part of the team (PC-1).	6,3	0,7
18	Applying the safety regulations of various production processes in response to emergency situations (PC-10).	6,3	0,8
19	Identifying dangerous areas, extremely hazardous areas, and areas of acceptable risk (PC-17).	6,3	0,6
20	Applying the calculation methods for technological equipment components in accordance with the efficiency and reliability criteria (PC-4).	6	0,5
21	Performing installation and erection of the equipment, operating protective equipment (PC-6).	4,5	1,23
22	Organizing and performing maintenance, repair, conservation and storage of protective equipment, monitoring the condition of the protective equipment, make decisions on the replacement (recondition) of the protective equipment (PC-7).	4,3	1,25

The obtained data reveals that the degree of professional competence development in engineering students is satisfactory. The mean value for all competencies is 6.8. There is a very significant dispersion in mean values for various competences: from 4.3 (PC-7) and up to 8.5 (PC-14). According to the respondents, the most important professional competences (PC-12 and PC-9) are developed at a level higher than average.

The respondents who are studying in an academic major 13.03.02 "Electric Power Engineering and Electrical Engineering" identified several professional competencies from twenty-one listed below, which were most useful to them during their on-site practical training at the Vostochny spaceport, and also pointed out their importance for the engineer:

- justifying the project solutions (66 %);
- applying standards and regulations for workplace safety, industrial health, industrial fire protection and occupational safety (66 %);
- performing the installation of professional equipment elements (60 %) (Table 3).

Table 3. Assessment of the professional competencies development (academic major 13.03.02 "Electric Power Engineering and Electrical Engineering")

No.	Professional competences	Mean value	Standard error of the mean
1	Testing the commissioned electric power equipment and electrical equipment (PC-12).	8,8	0,4
2	Applying standards and regulations for workplace safety, industrial health, industrial fire protection and occupational safety (PC-10).	8,3	0,2
3	Compiling and categorizing standard technical documentation (PC-9).	8,1	0,8
4	Designing engineering objects in accordance with the functional specification and technical and regulatory documentation, in compliance with various technical, energy-efficient and environmental requirements (PC-3).	8,1	0,7
5	Processing the results of experiments (PC-2).	8,1	0,3
6	Using technical means to measure and control the main parameters of the technological process (PC-8).	8	0,4
7	Participating in pre-commissioning procedures (PK-13).	8	0,9
8	Organizing the work of small teams (PC-19).	8	0,7
9	Designing, preparing and conducting typical experimental studies in accordance with the specified methodology (PC-1).	7,8	0,5
10	Justifying the project solutions (PC-4).	7,8	0,9
11	Preparing purchase orders for equipment and spare parts and preparing technical documentation for repairs (PC-17).	7,8	0,9
12	Resolving issues connected with work organization and work standardization (PK-20).	7,8	0,6
13	Repairing equipment according to the specified methodology (PC-16).	7,6	0,4
14	Providing the required modes and specified parameters of the technological process according to a specified procedure (PK-7).	7,5	0,5
15	Evaluating the main production assets (PC-21).	7,5	0,9
16	Estimating the parameters of engineering equipment (PC-5).	7,3	0,8
17	Determining the working modes of engineering equipment (PC-6).	7,3	0,3
18	Coordinating the activities of team members (PC-18).	7,3	0,7
19	Performing the installation of professional equipment elements (PC-11).	7,2	0,3
20	Applying methods and technical means of operational testing and diagnostics of electric power equipment and electrical equipment (PC-14).	7,2	0,5
21	Assessing technical condition and residual life of equipment (PC-15).	7,2	0,6

Comparative analysis of professional maturity level showed that there is no significant difference between the levels of professional competence of students majoring in "Informatics and Computer Technology" and "Technosphere Security". Level of professional competence on “Electrical Power Engineering and Electrical Engineering” considerably exceeded the levels of students majoring first two qualifications, i.e. students of “Electrical Power Engineering and Electrical Engineering” are more competent and professionally mature (Table 4).

Table 4. Comparative analysis of the level of professional competences for engineering majors

Average	Academic major			Significance value of t-test for independent samples		
	Informatics and Computer Technology (1)	Technosphere Security (2)	Electrical Power Engineering and Electrical Engineering(3)	p_{1-2}	p_{1-3}	P_{2-3}
M±m	6,4±0,26	6,8±0,21	7,7±0,09	p>0,05	p<0,05	p<0,05

Notation: Student t-test values – P1-2 (0,245), P1-2 (0,01), P1-2(0,00)

As can be seen from the obtained data, engineering students in the field of study "Maintenance and operation of technological equipment and power supply systems for the rocket launch site" within the academic major 13.03.02 "Electric Power Engineering and Electrical Engineering" estimated their level of professional competences development as quite high. The mean value for all competencies is 7.7.

Engineering, like any other professional activity, has its own specific features and requires a certain set of personality qualities. In order to study the personal attributes necessary for an engineer to perform professional activities, respondents were asked to list the personal qualities necessary for the young specialist (open question of the questionnaire). They identified the following qualities: ability to work in a team, work initiative, competence, ability to learn quickly, responsibility, communication skills, stress resistance, leadership qualities, and commitment to professional development.

In conclusion, the respondents were asked to formulate the existing limitations in the vocational training of engineering personnel at the university, which they had to deal with during the on-site (pre-diploma) practical training at the Vostochny spaceport.

The following limitations were identified: insufficient time for practical training (the amount of on-site practical training stipulated by the intramural education programs is clearly insufficient); inadequate facilities and recourses; lack of knowledge and specialized and vocational disciplines; weak interdisciplinary connection between vocational disciplines, between theory and practice.

4. Discussion

In this study we used the following resources:

- notions of engineer's professional development from A.A. Aleksandrov, I.B. Fedorov, V.E. Medvedev, L.M. Mitina, E.F. Crawley and others;
- principles and specific features of the engineers development from N.S. Glukhanyuk, E.V. Dyachenko, E.A. Klimov, A.K. Markova and others;
- theories on constructing the content of vocational education programs by B.S. Gershunsky, D.A. Voloshin, A.A. Kirsanova, V.G. and Y.G. Tatur and others.

However, as the study shows, there is a shortage of contemporary research studies on building a system of vocational education and training of engineering personnel for high-tech businesses, and they do not allow us to examine the complete system of vocational engineering training.

5. Conclusions

The study proves the necessity of constructing a system of vocational education and training of engineering personnel for high-tech businesses on the basis of the Federal State Educational Standards which is aimed at developing students in such a way that they fully comply with professional engineering standards.

The vocational engineering education and training in the academic setting should be a system of organizational and teaching activities that should enable the graduates to be professionally ready for their future job.

As a result of this study, we can identify the main approaches to constructing of the engineering education content in the university: person-centered, systemic, competency-based and integrative.

Important requirements for the basic engineering education are:

1) enhancing the students' intellectual abilities, increasing their willpower and improving their organizational skills;

2) increasing the requirements for the integrity, flexibility and breadth of engineer training;

3) vocational training should include preparation for acting simultaneously as a researcher, technical expert and the head of the enterprise, which would expand the area of engineer's responsibility.

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