

On the Continuity of Engineering Training in the “School-University” System Based on the Creation of a Center of Modern Competencies

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Abstract. Technological education of schoolchildren is currently a priority for the development of educational systems. Intensive development of nanotechnologies, robotics, biotechnologies requires improvement of competences of scientific and technological personnel, integration of knowledge and various directions of professional activity. Training of engineering personnel is possible only in the system of continuous professional education, each level of which provides step-by-step formation of competences of the specialist. The article deals with the problem of continuity of engineering training. The solution to this problem can be achieved by means of specially organized pre-university training of students, which is oriented towards training in basic subjects related to engineering training in secondary school and university. Unique opportunities to implement continuity of general secondary and higher vocational education programs are offered if there are structural subdivisions in higher education institutions engaged in such pre-university training. A new division - the Center of Modern Competencies - has been created at Vologda University. The educational center implements projects: "Children 's University," Small Academy, "Technology lesson." In the Center for Modern Competencies of Children through educational programs, schoolchildren form modern competences, primary skills of project management, team work, research and inventive skills, knowledge of the foundations of modern technologies, including programming, use of big data, information resources.

1. Introduction

Educational systems in many countries are currently focused on technological education of schoolchildren. This is due to the development of the industrial sector of production; with the ever-growing need for training of highly qualified engineers not only in the areas of high-tech production, but also in the service sector (transport, telecommunications and communications, housing and communal services). Further intensive development of nanotechnology, robotics, biotechnology requires improving the competence of scientific and technological personnel, the integration of knowledge and various areas of professional activity. It is becoming increasingly obvious that the training of engineers is possible only in the system of continuing professional education, each level of which provides a phased formation of specialist competencies.

2. Literature review

Foreign specialists in technological education distinguish the following directions-orientations of its development: craft skills, industrial production; design; improving the quality of scientific knowledge through the development of new technologies; high technologies; key competencies (cooperation, organization, communication, responsibility, etc.); engineering competencies [13].

The main professional characteristics of engineers include: knowledge of promising areas of science and technology, unique advanced technologies, modern engineering methods and tools, willingness to use innovation, entrepreneurial activity, the ability to think creatively and systematically in variable conditions, the availability of skills in a team, the ability to professional mobility, change the type of labor functions depending on the needs of society [4], [5], [7].

Training of such engineers is possible only in the system of continuous professional education, each level of which provides a phased formation of specialist competencies [1], [2]. In recent years, many scientists are working to improve the forms of pre-University engineering training, offering non-standard forms and methods of work with applicants, including work in a real research team, network educational programs, the use of virtual platforms and simulators for training [6], [8], [11]. According to T. Yu. Tsibizova [12], pre-University training is defined as a synthesis of learning and teaching, education and self-education, development and self-development, professional self-determination, adulthood and socialization; as a means of differentiation and individualization of learning, when due to changes in the structure, content and organization of the educational process more fully takes into account the interests, inclinations and abilities of students.

3. Problem statement

The problem of continuity of education has long been considered by many scientists, both in General didactic and psychological terms, and in the methodological. The solution of this problem is closely connected with the implementation of the principle of continuity – one of the most important requirements of the methodological system of teaching any fundamental Sciences.

In the most common sense, continuity is the relationship between phenomena in the process of development. In pedagogical terms, continuity is a General pedagogical principle, which requires constant provision of inseparable connection between the individual parties, parts, stages and stages of training and within them; expansion and deepening of knowledge acquired at previous stages of training; transformation of individual concepts and concepts into a coherent system of knowledge and skills.

A special place in the implementation of continuity is the transition from one level of training to another. This is because the transition represents a leap in human learning and development. And at jump part of connections between elements is broken, "breaks". It is here that it is particularly necessary to identify the continuity and to soften the transition from one stage to another.

The basis for the implementation of the continuity of educational programs at different levels and stages of continuing education is its fundamental content. Without a proper, deep understanding of the continuity of the impossible effective organization of the entire learning process at school and in high school. Connections in the content of education genetically go back to scientific connections and Express the structural unity of educational material. Implementation of the principle of continuity allows to make more effective work on the development of creative abilities of pupils and students.

However, in pedagogical science insufficient attention is paid to the continuity of relations in the direction of school-University, ie, how to teach students mathematics, physics, computer science so that they are most ready for the perception of University courses. Usually it comes down to either preparing for the exam, or to conduct career guidance. Meanwhile, in this direction there are many problems in the content of education: what material and to what extent should be studied in school in order to prepare for the perception of University courses. Experience shows that even many of those students who studied in schools and classes of physical and mathematical profile, are not sufficiently prepared to ensure that in a time deficit deeply and firmly master the course of higher mathematics.

From a practical point of view, the continuity of General secondary and higher professional education implies, first of all, the continuity of state requirements for the training of school graduates and the content of state standards of higher professional education. However, there are serious conceptual differences between them. The situation is complicated by the fact that there are no entrance requirements in the University standard [9].

One of the most important conditions of succession is a qualified selection of students for admission to the University. This issue is very relevant in modern conditions. Selection of applicants using the exam suffers from shortcomings, as focused more on checking the amount of information stored, checking the level of training of students in solving standard problems. Analysis of the results of the exam shows that about half of the applicants do not confirm their assessments in the future. The level of learning of students is primarily determined by the level of their learning abilities, knowledge of UUD: Therefore, when going to University, it is necessary first of all to check the level of such abilities. For this purpose, much more effective are the heuristic conversations of the teacher with applicants [3], [10].

4. Theoretical part

The reasons for the difficulties in trying to ensure continuity between secondary and higher education are that secondary education has three main objectives that contradict each other: (1) to provide students with a minimum of knowledge that should be considered necessary for every educated person; (2) to prepare students for practical activities of any kind; and (3) to prepare students to continue their education in higher education.

The solution to this problem can be achieved with the help of specially organized pre-University training of students, focused on continuity in teaching the main subjects related to engineering training in high school and high school.

At the same time, pre-University engineering training is considered as a process of quasi-professional training, as a stage of orientation of entrants to obtain engineering education and subsequent adaptation to the educational process of the University. Numerous directions of development of the content of pre-University training are determined taking into account a wide range of modern high-tech industries.

A special place in the implementation of the continuity between the school and the University is occupied by lyceums, gymnasiums, specialized classes of engineering and physics and mathematics. In this case, secondary education is implemented on the idea of profile differentiation and is focused largely on vocational guidance and appropriate training of students.

Many researchers consider pre-University training not only as a stage of professional self-determination. The tasks of pre-University training also include organization and coordination of career guidance, planning of University-wide work on a new set of students, organization of additional training for schoolchildren in General subjects, stimulation of professional self-determination of schools.

5. Experimental study

Practice shows that pre-University engineering training is not always provided by traditional methods. With the participation of the leading oil and gas corporations of Russia, pre-University engineering training is carried out in the form of specialized classes that operate in secondary schools, lyceums with direct support and on the basis of secondary professional educational institutions. Specialized Gazprom Classes have been established in five Federal districts of the Russian Federation. Each class has its own subsidiaries, supporting universities or secondary professional institutions of oil and gas profile. Teachers are invited from these institutions to give lectures and carry out practical work. During the training, students make their professional choice, adapt faster, integrate into the corporate culture. In the specialized Gazprom-class school Vologodskaya region teachers VoGU classes in-depth study of mathematics, physics, computer science, for students are organized thematic lectures that introduce the profession and industry, tours of the gas station, in the laboratory of the University,

thematic class hours. For this school, a two-year program was developed, which has a modular structure and includes corporate education, University design and research, competitive evaluation and personal resource blocks.

Unique opportunities to implement in practice the continuity of programs of General secondary and higher professional education are provided in the presence of structural units in universities engaged in such pre-University training. A new subdivision – the center of modern competencies – was created at Vologda University. In this unit, there are rich opportunities for special organization of thematic classes or special courses for high school students for continuous engineering training.

The creation of the center of modern competencies of children at the University solves a number of important tasks: the development of modern competencies in schoolchildren, the formation of a new type of thinking of students who share the value of self-development throughout life and a conscious approach to education, able not only to receive information and operate it, but also to know how to obtain it, verify and use it for their further development. In such centers, a new role is assigned to the teaching staff as a mentor-organizer of children's project teams. It is possible to achieve high results in such centers in cooperation with international and Russian companies.

The educational center implements the following projects: "Children's University", "Small Academy", "technology Lesson".

The Children's University implements additional General development programs for children enrolled in programs of basic General education (grades 5-9). In the "Small Academy" additional General development programs are implemented for children enrolled in programs of secondary General education (grades 10-11) and secondary vocational education, potential entrants, in priority areas.

The main goal of the project "technology Lesson" is to update the content and technologies of teaching the school subject "Technology" and the implementation of lessons in a network form with the use of infrastructure, material, technical and human resources of the organization, carrying out educational activities in higher education programs, commissioned by the regional education system.

Within the framework of the project "Technology" the following programs are implemented: "industrial design", "Robotics", "Geoinformation technologies", "Aero-technologies", "IT-technologies", "Virtual and augmented reality".

The program "industrial design" is aimed at developing practical skills in the design of mass production facilities, working with modern equipment and computer programs and stimulating the interest of students to technical creativity.

As part of the course "Robotics" students are introduced to the basics of designing and programming robots. Classes in robotics teach children to apply theory in practice, to solve problems with non-standard methods.

The program "Geoinformation technologies" is aimed at the formation of practical skills in the field of geoinformation systems, work with geospatial data, orientation and navigation on the ground, the study of modern technologies for processing materials and data, the study of the world with the help of modern technologies and stimulate the interest of students in technical Sciences.

Studying the program "Aero-technologies", students get acquainted with the physical, technical and mathematical concepts of this area, program unmanned aerial vehicles. The acquired knowledge is used in creative projects.

The purpose of the IT-technology program is the development of Soft-competencies by students in the field of "smart" electronics and its programming through the use of case technologies with the use of programmable microcontroller platforms.

In the course of practical training on the program "Virtual and augmented reality" students master the technology of virtual, augmented and mixed reality, realize their features and capabilities, identify possible applications, as well as identify the most interesting areas for further deepening of their knowledge. This organization of training contributes to the development of skills of design thinking, design analysis.

6. Conclusion

Experience shows that in the Center of modern competencies through educational programs students develop modern competencies, primary skills of project management, teamwork, research and inventive skills, knowledge of the basics of modern technologies, including programming, the use of big data, information resources.

References

- [1] Afanasiev V V, Vasilyeva M A, kunitsyna S M, Feshchenko T S 2016 Principles of organization of system of profile training Education and science in modern conditions : materials VIII international. scientific.scient. Conf.(Cheboksary, 26 June 2016) (Cheboksary: Interactive plus) **3(8)** pp 35-43
- [2] Zhuravlev M V, Ovsienko L V, Bashkirtseva N Yu, Ibrashev L R, Emelyanova O P 2018 pre-University engineering training in an international context *Higher education in Russia* **1** pp 54-60
- [3] Alminderov V V, Giza T, Zavalko N A, Iovchuk N M, Kravtsov A V, Lebedev A N, Nikitin A A, Nikitina O A, Pufahl the Struzikom I, Rechitskaya E G, Solodova E A, Suleymanov D S, Tests V A, Shakirova D M 2017 Intellectual and creative endowment Interdisciplinary approach Monograph (M.: Scientific adviser) 220 p
- [4] Kalney V A, Makhotin D A 2015 Modern approaches to the development of technological education in educational institutions *World of science, culture, education* **4(53)** pp 65-68
- [5] Kalney V A, Makhotin D A 2015 Technological education in post-industrial society *Bulletin of the rmat* **3** pp 68-76
- [6] Khosheutovo O L 2012 pre-University training as a stage of professional self-determination personality *Philosophy of education* **4(43)** pp 174-179
- [7] Makhotin D A 2016 Engineering training in the technological education of students *Ka-Sanski pedagogical journal* **2** volume 2 pp 301-304
- [8] Moscow project "Kurchatov center for continuous convergent education" Website of the Moscow Department of education <http://dogm.mos.ru/projects/modernization-of-the-system-of-general-education-in-the-city-of-moscow/>
- [9] Senashenko V S 1997 Continuity of General secondary and higher professional education *Higher education* **1** pp 53-56
- [10] Testov V A 2014 Mathematical giftedness and its development *Perspectives of science and education: international electronic scientific-practical magazine*: **6** pp 60-67 <http://pnojurnal.wordpress.com>
- [11] Hatuntsev Y L 2013 Technological education of students is the first step of the innovation-technological development of the country proceedings of the XIX International conference on problems of technological education students; ed. by Y. L. Ho toncheva. MGTU im. N. E. Bauman pp 4-16
- [12] Tsibizova T Yu 2015 Principles of organization of research activities of students in the system of continuing education *international journal of experimental education* **10(1)** pp 20-22
- [13] Technology Education for Teachers 2012 Edited by P. John Williams University of Waikato, Hamilton (New Zealand)