- International ECTS requirements (*ECTS and Diploma Supplement – European Community Course Credit Transfer Systems*).

Authors of the proposed module and study and guidance materials database on "Innovatics" for the realization of study programmes in modular and network forms, and of e-learning and distant learning are confident that the disclosed method for continuous innovative training of specialists and the "Innovatics" module in case of their wide-spread introduction could assure the enhancement of engineering training at HEIs up to the level of the leading universities of the world.

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Concept of Subject Area "Technology" as a Way to Modernize Learning Content and Methods at Modern School

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The paper presents the main idea of "Technology" concept developed by the team in Russian Academy of Education. The concept distinguishes the basis and the main areas of learning content and methodical modernization in technology education at Russian schools.

Key words: technology education, design and technological culture, subject area "Technology", learning content, learning methods, engineering and technology training.

Problem statement

Recently, teaching communities and professional associations have been actively debating the need to modernize the learning content and teaching methods in the subject area "Technology".

The post-industrial society is in demand for highly-qualified specialists who are ready to live and work with ever-changing technologies and technological systems. The inconsistency between this demand and the level of school leavers' knowledge has become the reason for sharp critics of modern technology education at Russian schools.

Engineering competencies, systems thinking and creativity, communication skills, ability to analyze scientific and technical data, work with technical documents are the basic personal attributes that are in demand in the modern society. It is these attributes that shape the technological culture and should be developed within the subject area "Technology".

In the context of high-tech manufacturing and breakthrough technologies, the level of technological culture defines human resources of the economy and production of the country, its competitiveness on the global market, intellectualization of human capital and knowledge-intensive activities, as well as ensures security and culture of manufacture and other technological processes.

In foreign countries, the education system, in which the subject area "Technology" plays a significant role both due to its importance and high volume of content in the basic education, allows educators to shape strong human resources for further professional education and, thus, ensure competitiveness of manufacture on the global market. Great Britain, France, Germany, USA, Israel, South Korea, China, etc. are among these countries.

Worldwide, the competitiveness of the education system that is a key condition for sustainable development of the national economy, manufacture, defense capacity and national security is ensured by the following: 1) improvement of pupils' academic training, especially in the field of natural sciences and mathematics; 2) enhancement of science and technology literacy (culture) of school leavers, which would enable them not only to use effectively up-to-date technologies at the personal level, but also to succeed in acquisition of modern technological systems and procedures at the professional level, i.e. design and management of machines and technologies. The second trend is in its broader sense technological (polytechnic) education of young people, one of the components of which is the subject area "Technology" taught at school.

Relevance and grounds of the concept

At the instruction of the President of the Russian Federation (RF) and resolving the tasks of the Federal target programme "Education development from 2015 until 2020" (objective 2 – development of modern methods and technologies for secondary education), the Russian Academy of Science has developed the Concept of the subject area "Technology" and initiated the expert seminar. The proposed concept is currently being debated by teaching and academic communities.

The concept rests on the following ideas: shaping youth technological culture, preparing young people for work and further education, including development of such attributes as willingness to work and respect for work; involvement of pupils into all types of organizational culture (traditional, corporate-handcrafted, professional, design-engineering) with the corresponding technologies and social roles; diversity of engineering training (with regard to regional peculiarities); acquiring competency in universal activities (design, research, management); identification of "through study paths" in engineering training, which would explain the logics of studying this or that technology of material processing, energy, and information; assistance in entering labor market, first experience such social roles as employer, businessman, service technician, designer, technician, manager, and others relating to acquisition of knowledge about engineering and technology in the course of professional activity [1].

Today, the subject area "Technology" is referred to:

- *school subject* (studied by all pupils starting from 1 to 11 grades. As a learning outcome, pupils gain understanding of engineering and technology, get familiar with the world of engineering profession and labor, achieve meta-subject outcomes by the example of practical activity);
- *specialized subject* (for various specializations in 10-11 grades at school. It is aimed at studying such technologies and technical systems which are specific for the chosen occupation);
- *social and engineering-manufacturing internship* (it is designed to prepare pupils for actual workplace, professional activity under the conditions of industrial, social, and volunteer practice).

Within the learning content, the subject area "Technology" serves as a basic integration mechanism that allows pupils to synthesize knowledge of natural science, technology, business, humanitarian during design and engineering activities. Additionally, it enables them to apply this knowledge appropriately in various fields of human activity, which contributes to assuring pragmatic (applied) character of secondary education.

The learning outcomes of the subject area "Technology" are designed so that to ensure such level of a personal technological culture that is required for sustainable development of society, national economy and manufacture. This level implies [2]:

- ability to comprehend, apply, control, enhance and evaluate technologies in the process of modification;
- acquisition of universal competencies within such activities as design, research, and management;
- ability to address the contradictions and reveal the problems in practice by means of adequately selected and applied technologies;
- commitment to creative and untraditional actions, willingness to develop new products, new mode of action, new mechanism to act on the subject of labor, etc.;
- conscious choice of future profession by trying various occupations in the course of secondary education;
- commitment to work and constant self-development that implies acquisition of new knowledge, skills, and competencies during engineering activity;
- flexibility and ability to adapt to the ever-changing conditions in uncertain situations.

Main principles of the Concept

The main objectives of technological education at secondary school are to foster pupils to acquire, transmit and change technological culture.

In addition, technological education may also serve both as a tool of socialization and personality development, and a method to forge the technological culture.

Being a component of culture as a whole, technological culture is regarded as prerequisite and result of the technological education. Despite the fact that the notion of technological culture was proved as a scientific term at the end of 20th century, its meaning remains constant and it includes [3]:

1) a set of technical tools, technologies, units, management and control systems, hardware and software packages and etc. designed during modernization (objective results of human activity);

2) subjective human forces and abilities applied during modernization: knowledge, competencies, abilities, profession-related personal attributes, etc.

Being a reflection of objective and subjective results of human activity, the technological culture changes due to scientific and technical progress, implementation of new technologies, emergence of new problems in machine maintenance and control. Each era is characterized by its own set of components which comprise the technological culture, i.e. technological environment. Thus, technological environment can be termed as a unity of objectives and subjective results of human activity in a certain historical moment, a moment of studying relationship between personality and the artificial world.

The technological environment determines the conditions and provides the possibility for modernization. Correspondingly, it defines the peculiarities of technological culture development among pupils, i.e. it influences the developed educational environment. In this regard, the main goal of human education is to harmonize the requirements of the technological environment with the level of person's training, i.e. his/her readiness for modernization within this environment.

Today, the technological (engineering) education has entered a new stage in its development and is trying to resolve the issues of revising the content and learning outcomes of "Technology" curriculum taught at schools. This issues are worldwide discussed by educational communities.

One of the basic principles that underpins the technological (engineering) education is the concept of changing forms of human activity in this or that type of society (A.M. Novikov). The concept outlines four types of organizational culture of society – traditional, corporate-handcrafted, professional (scientific), design-engineering [4], which directly refer to labor and manufacturing processes at a certain development stage of machinery and technology, science, and social relations.

The design-engineering organization of modern postindustrial society rests on the idea of implementing various programmes and projects into practice via technologies of all kinds and with due regard to the factors that may influence implementation of these projects (economic, staff-related, facilities-related, environmental, etc.). It is due to this fact a separate branch of management – risk management – has budded off, and various types of project-oriented learning have gained particular popularity.

Within the proposed concept of the subject area "Technology", the idea that a pupil should get familiar with the design-engineering organizational culture and up-to-date technologies, which is reflected in the corresponding learning outcomes and programme content, is not sufficient. Additionally, pupils should gain knowledge of all types of organizational culture existing alongside traditional technologies (people have still used knifes, axes, hammers, people have still tied sailor's knots) and allow developing fine motor skills, coordination, practical skills in using manual (as well as electrical) instruments and shaping labor culture and corresponding personal attributes.

In the course of modernization, the visions for materials, tools, technological processes, peculiarities of labor organization, relating both to the current technological environment and that of the past and future, are shaped. These visions define the model or the landscape of the artificial world where certain regularities, principles, theories, and relations are in force [5]. The analysis of modernization and technological knowledge accumulated by humanity through the lens of goals and objectives of secondary education allows formulating fundamentals that should be studied at school regardless subject, module, and peculiarities of technological (engineering) training.

Such fundamental notions that define the core of technological (engineering) education are as follows:

1. Material.
2. Energy.
3. Information.
4. Technical systems.
5. Technology. Technological processes.
6. Design.
7. Research (structure, functions, methods).
8. Organization and management.
9. Relations (person-machinery, person-technology, machinery-technology, etc.).
10. Economics and ecology.
11. The past and future of technology (history).
12. Innovative creative work and invention activities.

The subject area "Technology" is the only mechanism to shape the technological culture, i.e. one of the components of pupils' general education and personal culture. In the context of the Federal state education standard, the social, personal and cognitive development of pupils within the subject area "Technology" is achieved during:

- acquisition of scientific (theoretical) and technological knowledge in the course of practice-oriented and engineering activities;
- analysis of the world of machinery and technologies, examination of material properties and characteristics, investigation of opportunities to control technical systems and technological processes;
- study of traditions of peoples that inhabit Russia, cultural and national peculiarities of handicraft and products of decorative and applied arts, mastering various types of material art processing and industrial design;
- self-determination of pupils in workplace related activities, from workspace organization up to identification of career preferences, choice of career path and personal growth.

The subject area "Technology" is comprised of a number of subjects and modules (invariable and variable) aimed at achieving the desired personal, subject-related and meta-subject outcomes on the basis of practice-oriented activities of pupils.

The subjects make up the core of technological (engineering) training of pupils. They are designed to familiarize pupils with the fundamentals of engineering education both at general and specialized levels, as well as via practice-oriented classes and internship.

There are the following subjects (fig. 1.):

- "Handicraft" as a school subject (from 1st to 9th grades).
- "Technical drawing and design engineering" (from 7th to 9th grades).
- "Introduction into professional activity" as a specialized technical subject (according to the specialization in 10th-11th grades).
- "Internship" (from 7th to 10th grades).

Modules are designated to familiarize pupils with various aspects of technological (engineering) training. They are basically variable and are taught within all core subjects:

- Scientific and technical information and technical documentation.
- Technological systems and processes.
- Analysis of materials and structure;
- Design and modeling.
- Methods to solve design and project problems.
- High technologies.
- Technology management and control.
- Design and project fulfilment.

The modules are designed in the way so that they have the same learning content, learning outcomes, teaching aids, facilities, and requirements for teacher's qualification.

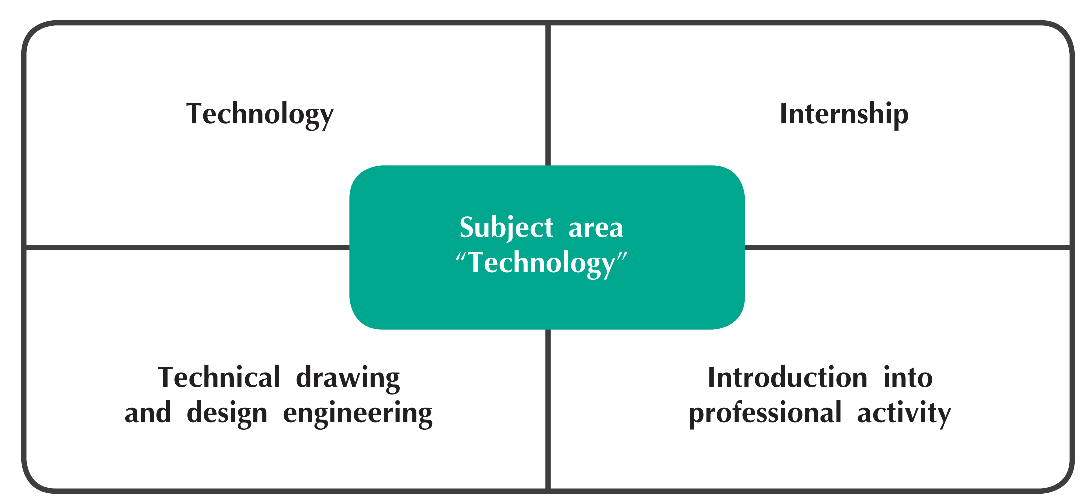
The subjects and modules of the subject area "Technology" are taught both during class hours and outside the core schedule on the grounds of the basic education programme and its variable components. The model to implement the subject area "Technology" is defined in accordance with the teaching standards of a region.

The variable modules of the technological (engineering) education can be developed within three areas of modern industry – engineering, agro-technological, service-technological (sphere of services). Additionally, the variable modules may imply education by means of integrative environment (for example, robotics technology, modern energetics, transport systems and machinery). The variable modules account for not more than 30 % from the content of the education programme in "Technology". Extra hours can be received due to outside activities and individual planning.

The variable modules of technological (engineering) education can be implemented not only be means of regional education development programmes, including that of technological education development (both at the school level and regional one – long-life technological education in a region), but also due to intensive cooperation with social partners, local industries, representatives of small- and medium-size business, innovation centers, and professional educational establishments.

The role of social partners is to generate the demand for this or that module, define the trajectory of pupils' technological (engineering) training, provide access to their facilities and industrial sites, participate in educational process as experts, masters,

Fig. 1. Structure of the subject area "Technology"



project supervisors who would formulate workplace-related design and technological tasks (cases, projects) and take part in development of joint research projects, industrial initiatives and startups.

Secondary schools should promote active participation of pupils in various competitions and contests in engineering and art. However, the basic priority for pupils is to take part in All-Russian Pupil Olympiad in Technology JuniorSkills, regional youth contests and projects aimed at developing design art, project thinking, and entrepreneurial skills.

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Innovative Technology for Mass Training: Case Study of e-Course "Mechanical Engineering"

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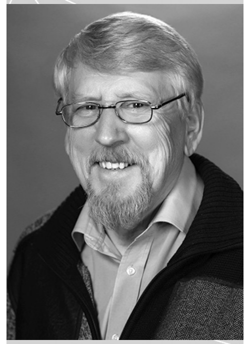
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The paper describes a course "Mechanical engineering" set up on the National Open Education platform. The course has a well-balanced system of authors' solutions, special practice-oriented tasks that encourage students to learn and develop engineering thinking. The disguising features of the course are weekly-based structure that allows controlling students' independent work, a practical-cognitive module, and an interactive programming module.

Key words: e-course, open education, engineering thinking.

According to the current Federal Education Act [1], when implementing educational programmes the universities may use e-learning beyond the traditional educational technologies. The State Programme of the Russian Federation "Education Development" for 2013–2020 [2] has determined the priorities of the state policy in the higher education sector. Among the major priorities there are introduction of open learning; wide application of information-telecommunication technologies; ensuring information transparency of education system for the society; development of high-tech educational environment.

The technologies and priorities mentioned in the Act and described in the State Programme reflect the international trends of education development [3, 4]: mass character and internationalization which entails: changes in learning technologies taking into account modern engineering and social-humanitarian achievements; significant transformation of lecture-seminar learning model; wide use of on-line courses; implementation of active learning methods.

With the launch of the National Platform of Open Education openedu.ru there appears an opportunity for students to transfer credits supported by a certificate on the suggested on-line courses in Russian universities when learning programme of Bachelor's or Specialist's degree. The focus on engineering learning content is a path that the course authors have chosen. The authors did not only use technical potential of the National Platform at the most, but also changed the course content in many aspects due to its filling in with practice-oriented problems.

Designing the course to form the bases for engineering thinking, the task was set to motivate students to use all the variety of methodical innovations and potentials of information-telecommunication technologies. For this purpose, modern electron methodical content was developed in a wide range of information formats: lectures and examples of problem solutions accompanied by visual materials of actual process and phenomena; interactive learning manuals with comments of incorrect solutions; theoretical test questions and context problems on calculation of real constructions and mechanisms with a wide range of parameters; home assignments supported with stage-by-stage solution and stage-by-stage automated check; basic projects including several course sections. The pool of practice-oriented problems, tests, home assignments, basic projects with videos of real processes and phenomena, their sketches was formed. Multi-optional