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CONCEPT OF RESEARCH TRAINING OF TECHNICAL UNIVERSITIES STUDENTS

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Abstract

The relevance of the problem is due to the discrepancy between the competencies acquired by technical universities students in the process of training, the increasing requirements of employers, high-tech industries, designing organizations. The aim of the study is to develop and implement the concept of research training of technical universities students. On the basis of the analysis, the authors systemized and developed the existing scientific and pedagogical approaches to solving the problem. They also identified the main approaches and principles considered as methodological bases in the process of creating the concept of research training of technical universities students. The concept is presented as a system of provisions, which provides for the application of a program-targeted approach to the quality management of education, taking into account the employers' requirements to the level of graduates' readiness for research activities; specific features of research training and their impact on the formation of new didactics of a technical university in order to implement the requirements of educational and professional standards. The concept defines the need to monitor the quality of education, including the students' research competence formation. Empirical methods allowed to determine the level of technical universities students' research competence formation at all the stages of experimental work. To interpret the results of the experiment, the methods of mathematical statistics were used: they allowed to prove their reliability and the research training concept effectiveness. The materials of the paper are of practical importance for the teaching staff of technical universities.

Keywords: Research activity; research competence, research training

1. Introduction

The technological needs of the global economy challenge the country to improve the competitiveness of local production and industry in order to create a favorable investment climate, integration into the world economic space. This determines the change in the nature of technical education, determining the need for students' better orientation towards research activities, contributing to the formation of graduates' ability to develop and implement competitive technology (Biasutti, De Baz, & Alshawa, 2016).

One of the main contradictions of Russian technical education is the mismatch of competencies that graduates acquire in the process of training in technical universities to the requirements put forward by employers, representatives of high-tech industries. Technical universities graduates are insufficiently prepared for the development and implementation of new competitive technologies; they are not focused on research activities, due to the shortcomings of pedagogical theory and practice in the implementation of the need for the organization of the educational space of a technical university, providing students with research training in the context of competence-oriented technical education.

Trends in modern production determine the change in the nature of engineering activities, making demands on technical education to form the image of a mobile and competitive graduate as a humanistic and socially oriented person, focused on research in the process of professional activity (Kapenieks, 2016). Thus, the relevance of development and implementation of technical university students' research training concept, which will be adequate in modern realities, is obvious.

2. Problem Statement

Development of theoretical and methodological foundations of technical university students' research training aimed at ensuring the quality of a competitive graduate's education.

3. Research Questions

1. Methodological basis of technical universities students' research training.
2. Content of the concept of technical universities students' research training.
3. Implementation of the concept of technical universities students' research training.

4. Purpose of the Study

Development and implementation of the concept of students' research training in the context of competence-oriented technical education

5. Research Methods

- theoretical methods: study, analysis and synthesis of existing research, literature, Internet resources on the problem; modeling of the educational process; generalization of research results;
- empirical methods: research and analysis of regulatory documents, interviews, observation, testing and analysis of activity results, pedagogic projects;

- experimental methods: pedagogical experiments, processing of results.

6. Findings

6.1. Methodological basis of technical universities students' research training

In the process of solving the problem of technical universities students' research training at the methodological level, the main reference point was the competence approach that determines the understanding of modern technical education meaning. Many ideas of the competence approach appeared as a result of studying the situation in the labor market, determining the employment requirements, which are formed on it.

The study, the analysis of papers on competence-based education made it possible to determine that to decompose the structure of higher technical education, to reorient its target and effective settings is possible on the basis of the theoretical and methodological base of the competence approach, which acts as a link between practice and theory and is able to implement links between universities and employers, having a practical and effective-target orientation.

A competence-based approach, interacting with traditional approaches (axiological, value-motivational (Factorovich, 2012), synergistic, integrative (Panferov & Bezgodova, 2019), activity (Henner, 2018; Jurgena, Cadere, & Kevita, 2018), context (Verbitsky & Larionova, 2009) is the backbone one and is making fundamental changes in the learning process, reflected in the strengthening of the practical orientation and the instrumental focus of engineering education, creates optimum opportunities for the students to research.

Methodological principles (continuity, integration, unity of educational space, practice orientation, intensification of training, creativity and activity orientation, reflexivity), which specify the provisions of the competence approach and along with it, which are the methodological foundations for the creation of the concept. The implementation of the competence approach and methodological principles involves the revision of the goals, content, methods of technical universities students training, which is possible when changing the management system at the university, in particular the quality management of education, focused on preparing students for research activities.

6.2. The content of the concept of technical universities students' research training

The concept of technical universities students' research training (hereinafter — the concept) is a set of views and concepts in the field of professional training of students, built on the basis of competence-based approach theory and the design principles of the research competence formation process, generalization of advanced pedagogical experience in this sphere, formed today, taking into account the needs of modern society and production. The concept of students' research training in the context of competence-oriented technical education defines research training as the basis for building innovative didactics of engineering universities, within the framework of the developing national system of qualifications, allows to implement the requirements of Federal State Standard of Higher Education on the formation of a complex of professional, special, general cultural competencies.

The concept describes the process of research training, means and methods of its implementation and includes (Figure 01): general provisions; methodological support; content - functional model of a technical university student's training for research activities; verification.
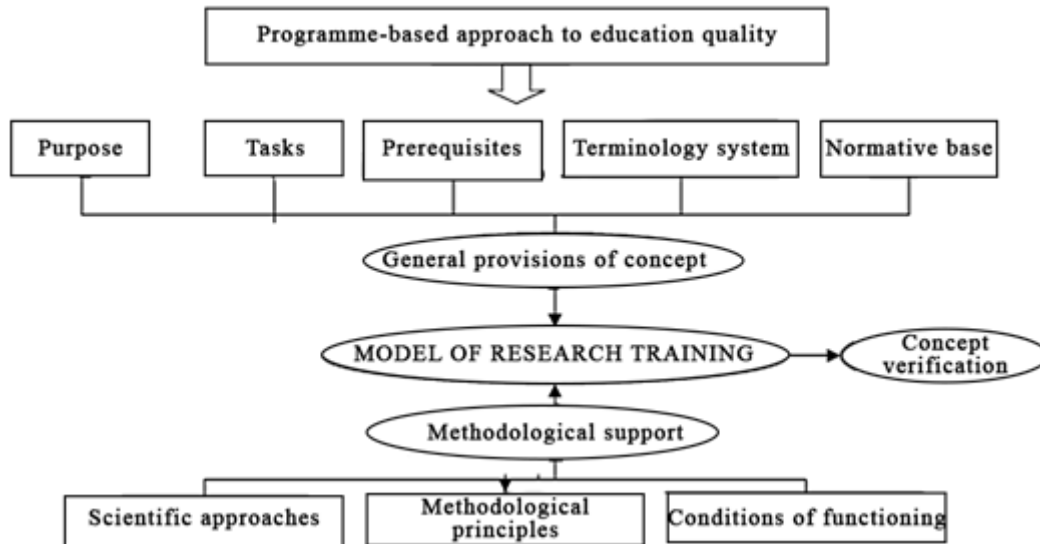

Figure 01. Structure of the concept of students ' research training

The purpose of the concept is justification of the creative engineering subject's formation process with a well-developed research attitude and reflection, ready to take an active part in the innovative engineering processes, capable of developing new ideas, of solving research production problems and taking innovative decisions.

The concept solves the following tasks:

- methodological bases of engineering universities students' preparation for research activity are defined;

- principles that form the basis for the effective selection of the content and technologies of preparation for research activities are formulated;

- components are structured and integrated into an integrated functional model, necessary changes are made in the process of professional training;

- criteria and indicators of readiness for research activity of a technical high school student are defined (Gorshkova, 2015).

When building the concept, it was determined that the prerequisites for its development are:

- specifics of modern engineering education (change of educational paradigm, introduction of competence-based approach in engineering education, the introduction of FES of HE; search for innovative pedagogical solutions to improve the efficiency of technical education) (Pipere, 2016);

- changing structure, content and nature of engineering activities, which are based on research aspects;

- changing requirements suggested to a technical university graduate, according to professional standards, requiring training of specialists capable of providing high production results and ready to carry out research;

- age and socio-pedagogical features of technical universities students (Erlina, Susantini, Wasis, & Wicaksono, 2018; Su, 2019);

- experience of pedagogical science in training engineers who are capable of adapting to changing production conditions; historical background, taking into account the experience of research training; results and experience of pedagogical research in this area (Pinheiro, Wangenheim, & Filho, 2018).

It should be noted that the higher the level of research activity of students and teachers is the more capable of progress a university is. In the engineer's activity, the research character manifests itself as a leading one. It gives ground to creative self-development, contributing to successful professional activity (Prayino, Suciati, & Titikusumawati, 2018). Therefore, the research training of students is a condition of the competitiveness of Russian technical education and we consider it a strategic reference point in the direction of which the professional training of technical universities students will be carried out.

Understanding of scientific and pedagogical, methodological foundations of the quality management system of university education, which motivates the participants of the educational process to improve the quality of educational activities, contributed to the transition to the program-target management system, which is characterized by the following features: focus on the final result; systematic understanding of the object; a planned level of quality; a comprehensive analysis of problems; an integrated approach to the choice of goals and means to achieve them; linking together goals and resources; striving for maximum efficiency in achieving goals with rational use of resources; integration of university and enterprise efforts.

A program-target system of education quality management allowed (Gorshkova, 2017):

1) to set realistic achievable goals, namely, the formation of students' readiness for research;

2) to organize the developing educational environment at universities;

3) to form a united team (university representatives, basic enterprises);

4) to develop a program of training for research activities (a functional model);

5) to guarantee the necessary support: personnel, material and technical, informational, methodological, etc.

Research training of technical university students was defined as a program of ideology of university work; therefore, a systematic monitoring of research competence formation quality is an integral part of the management system.

Having analyzed a number of works on the university educational environment organization (Belyaev, 2016; Yasvin, 2018; Blinov, Vinenko, & Sergeev, 2015), we came to the conclusion that a developing educational environment formation at a technical university is a prerequisite for solving the problem of creating innovative didactics of an engineering university, focused on the research training of the student, while taking into account the requirements of employers for the research training of graduates, characterized by an individual and productive style of engineering activities as well as professional standards requirements.

We consider a developing educational environment at an engineering university to be competence-oriented space, which creates a set of conditions aimed at ensuring the optimal parameters of educational activities of the university in the process of training the students for research activities, i.e. achievement of the target, substantial, operational, productive, and resource aspects.

Developing educational environment at a modern technical university includes the following structural components, which are provided with human, managerial and information resources.

Spatial and subject component: architectural and aesthetic organization of the educational process; symbolic space (symbols and traditions of the university).

Content component: a functional model of research training as the content of the concept.

Organizational component: human resource, management resource, communication sphere (partnership between teachers and students based on the adoption of common goals; harmonization of the interests of all participants of the educational process; creating an atmosphere of productive activity, organizational conditions. Personnel resource provides for the creation of a team of like-minded people, united by a common goal through the coordination of the structural units of the university, and individual teachers; improving the professional competence of university employees.

The informational component provides for network interaction with representatives of basic enterprises, the use of network educational resources, the introduction of an electronic system to support the educational process aimed at solving urgent problems of education informatization, including the development of the infrastructure of a common educational information space, the development of electronic educational resources.

The educational environment (Figure 02) is characterized by a structure in which the elements are interrelated and inseparable.
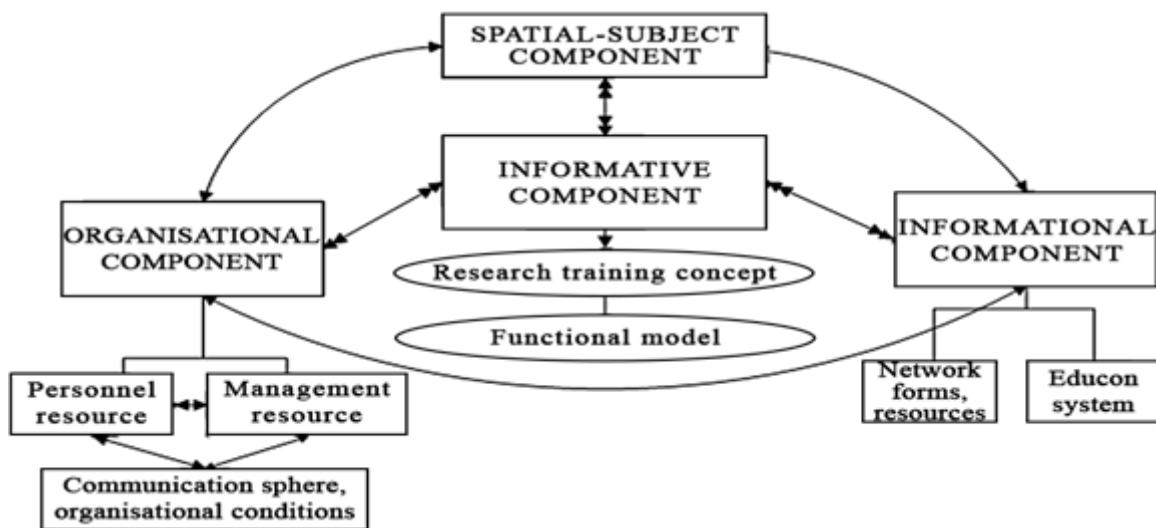

Figure 02. Structure of a developing educational environment at a technical university

We have proved that the creation of a developing educational environment requires:

- target orientation of students onto research and development;

- integration of education and research at all stages of the educational process;

- transformation of education content, development of new methodological support and improvement of the existing one; changes in organizational and technological foundations of the educational process;

- organization of interaction and joint activities of all subjects (teachers, university staff, representatives of basic enterprises, students), united by the environment;

- formation of a system of partnership with universities, research organizations, enterprises;

- expanding the set of FES of HE competencies through special competencies that contribute to the formation of students' readiness for research;

- providing personal and professional development of students, involvement in the process of co-management of educational quality in their self-organization while preparing for research activities.

6.3. Implementation of the concept of technical universities students' research training

The content of the concept is implemented in the functional model of preparation of students for research activities, which is the basis of innovative didactics of engineering universities. The concept is interdisciplinary, being part of the integral content of professional training. It is the basis of the organization of students' training for research process.

Evaluation of the effectiveness of the research training concept implementation, expressed in the assessment of the formation of technical universities students' research competence was carried out by means of criteria, indicators.

Cognitive - determines the degree of conceptual apparatus development, the ability to use the formed theoretical base in the process of research.

Personal - is for the motives and values of the individual, the student's reflection in the process of research.

Activity - determines the degree of skill in using the methods of performing research activities, the possibility of using the mastered methods of action and accumulated knowledge in practice.

Experimental work on the implementation and verification of the concept confirmed the effectiveness of its main provisions. The total number of people involved in the experimental work was 1520, including 1390 students and 130 teachers.

The experiment on the implementation of the concept took place in 3 stages. At the ascertaining stage, it was determined that at the entrance into the experiment, the research competence of first-year students was not formed, students with a low level of research competence dominate among the graduates (before the experiment), which reflects the results of the process of traditional vocational training in a technical university. At the forming stage, the pedagogical feasibility of introducing the concept of technical universities students' research training is proved empirically. The generalizing stage was aimed at assessing the effectiveness of the concept, by identifying the technical universities students' research competence formation dynamics. The results of the control sections are presented in Table 1.

Table 01. Dynamics of readiness for research activity formation, %

Personality component Motivational	2014-2015 academic year		2015-2016 academic year		2016-2017 academic year		2017-2018 academic year	
	Exp.	Cont.	Exp.	Cont.	Exp.	Cont.	Exp.	Cont.
Highest	0	0	3	0	3	1	3	1
High	0	0	27	2	37	3	45	9
Average	5	2	25	10	28	15	40	26
Low	53	38	30	58	29	61	10	54
Zero	42	60	15	30	3	20	2	10
Reflexive								

Highest	0	0	3	0	3	1	3	1
High	0	0	27	2	37	3	45	9
Average	5	2	25	10	28	15	40	26
Low	53	38	30	58	29	61	10	54
Zero	42	60	15	30	3	20	2	10
Cognitive component								
Highest	0	0	3	0	3	1	3	1
High	1	0	25	4	38	7	50	19
Average	4	2	25	18	32	25	40	38
Low	52	36	30	48	24	50	7	40
Zero	43	62	17	30	3	17	0	2
Activity component								
Highest	0	0	3	0	3	1	3	1
High	0	0	26	1	42	1	49	9
Average	5	2	27	20	35	30	40	43
Low	55	28	29	39	15	48	7	44
Zero	40	70	15	40	5	20	1	3

Comparison of the data of initial and final sections showed a stable growth of indicators for all components of the research competence of students in experimental groups in comparison with comparable results of control groups and the results of graduates before the experiment. The reliability of the results is confirmed by checking on the basis of statistical analysis using the criteria of mathematical statistics. The results of the experimental work show the effectiveness of the developed concept, implemented through a functional model of technical universities students' research training.

7. Conclusion

The concept of research training of students in the context of competence-oriented technical education, defines research training as the basis for building innovative didactics at engineering universities, which allows implementing the FES of HE requirements on formation of a complex of professional, special, general cultural competencies. The basic principles for the implementation of the concept are the following: a program-target approach to management — systematic monitoring of students' research competence formation; organization of a developing educational environment at the university, providing motivation, interaction and joint activities of all its subjects, united by the environment; integration of training and research at all stages of the educational process; transformation of education content, development of practice-oriented techniques, special forms and means of students' activities; taking into account the employers' requirements and professional standards on the basis of the formation of a partnership system with basic enterprises; students' involvement in the process of co-management of education quality in their self-organization in the course of research training; some criteria of the results and the ability of their being diagnosed.

The results obtained in the course of experimental work on the approbation of the concept's main provisions showed that its implementation contributes to students' development creativity, motivation, value attitude to research, readiness for active participation in innovative engineering processes, the ability to develop new ideas, solving research production problems and taking non-standard decisions.

References

Belyaev, G. Y. (2016) *Formation of the term "educational environment" in psychological and pedagogical literature of the late XX – early XXI century* (Educational environment as a subject of professional activity of a teacher. Retrieved from: http://dzd.rksmb.org/science/bel06.htm [in Rus.].

Biasutti, M., De Baz, T., & Alshawa, H. (2016). Assessing the infusion of sustainable principles into university curriculum. *Journal of Teacher Education for Sustainability*, *18*(2), 21-40 [in Latvia]. Retrieved from: https://www.researchgate.net/publication/312176811

Blinov, V. I., Vinenko, V. G, & Sergeev, I. S. (2015). *Methodology of higher education.* Moscow [in Rus.].

Erlina, N., Susantini, E., Wasis, & Wicaksono, I. (2018). The effectiveness of evidence-based reasoning in inquiry-based physics teaching to increase students' scientific reasoning. *Journal of Baltic Science Education, 13*(50), 972-985. Retrieved from: https://www.researchgate.net/publication/329946462 DOI: 10.33225/jbse/18.17.972.

Factorovich, A. A. (2012). Value-motivational management of quality of education in high school. In *Methodology and technology* (p. 330). Saarbrücken Germany, LAMBERT ic Publishing GmbH & Co. KG Dudweiler Landstr.[in Germany].

Gorshkova, O. O. (2015). Conceptual foundations of engineering universities students' professional training on research. *Alma mater (Vestnik Vysshei Shkoly)*, *1*, 58 – 62 [in Rus.].

Gorshkova, O.O. (2017). Preparing students for research activities in the context of competence-oriented engineering education. *Journal of Fundamental and Applied Sciences*, *9*(2S), 1445 – 1467 [in Algeria]. http://dx.doi.org/10.4314/jfas.v912s.853.

Henner, E. K. (2018). Professional knowledge and professional competence in higher education. *Education and science*, *2*, 9 - 16. [in Rus.].

Jurgena, I., Cadere, D., & Kevita, I. (2018). The Prospects of transdisciplinary approach to promote learnersí cognitive interest in natural science for sustainable development. *Journal of Teacher Education for Sustainability, 20*(1), 5-19. Retrieved from: https://content.sciendo.com/view/journals/jtes/20/1/article-p5.xml

Kapenieks, J. (2016). Educational action research to achieve the essential competencies of the future. *Journal of Teacher Education for Sustainability, 18*(1), 95-110. Retrieved from: https://content.sciendo.com/view/journals/jtes/18/1/article-p95.xml

Panferov, V. N., & Bezgodova S. A. (2019). *Methodological foundations and problems of psychology.* Moscow: Yurayt. [in Rus.].

Pinheiro, C., Wangenheim, C-G., & Filho, R-M. (2018). Teaching Software Engineering in K-12 Education: A Systematic Mapping Study. *Informatics in education, 17*(2), 167-206 [in Litva]. Retrieved from: https://eric.ed.gov/?id=EJ1195545

Pipere, A. (2016). Envisioning complexity: Towards a new conceptualization of educational research for sustainability. *Discourse and Communication for Sustainable Education, 7*(2), 68 - 91 [in Latvia]. Retrieved from: https://content.sciendo.com/view/journals/dcse/7/2/article-p68.xml

Prayino, B.A., Suciati, & Titikusumawati, E. (2018). Enhancing students' higher order thinking skills in science through instad strategy. *Journal of Baltic Science Education, 17*(6), 1046-1055 [in Litva]. Retrieved from: http://oaji.net/articles/2017/987-1544860627.pdf

Su, K-D. (2019). A feasible guidance for ordered multiple-choice items in students' hierarchical understanding levels. *Journal of Baltic Science Education, 18*(1), 77-89. Retrieved from: http://www.scientiasocialis.lt/jbse/?q=node/736

Verbitsky, A. A., & Larionova O. G. (2009) *Personal and competence approaches in education: problems of integration.* Moscow: Logos. [in Rus.].

Yasvin, V. A. (2018). Studies of the educational environment in Russian psychology: from methodological discussions to empirical results. *News of Saratov University. New series. Philosophy. Psychology. Pedagogy series, 18*(1), 65 – 75 [in Rus.].