FASHIONING OF RESEARCH COMPETENCE OF STUDENTS IN ENGINEERING UNIVERSITIES IN THE PROCESS OF INDEPENDENT AND SCIENTIFIC RESEARCH

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Abstract: The reviewed issue is pertinent today in view of the current disparity between the expanded need of the general public and the administration in brilliant college building instruction and the genuine development of designing alumni to play out their expert obligations, just as the deficiently created hypothetical establishments of understudy look into with regards to fitness situated training. The reason for this paper is to tackle the issue of framing the exploration fitness of understudies throughout autonomous and logical research work in the instructive procedure at College of designing. In view of the systematization and improvement of existing ways to deal with the arrangement of the issue of research preparing for designing college understudies adding to the advancement of a practical model, a philosophy for the development of research ability over the span of free and logical research work of understudies of building colleges is exhibited. The reasonability and convenience of creation and work of activity bunches concentrated on the satisfaction of imaginative research assignments is substantiated. The way toward forming pragmatic experience of research action with the interest of understudies in logical classes is depicted; the way toward utilizing ventures strategy through research assignments in the usage of coursework, capability works is displayed; settling and enhancing the experience of research exercises of future architects amid a wide range of training is considered. Exact techniques (poll, perception, interviews, testing, self-evaluation, documentation investigation, investigation of results of action, instructional structure) made it conceivable to examine the dimension of research fitness of understudies at all phases of the trial. The exploratory study included 1390 understudies and 150 educators and representatives of the college and essential undertakings. The educational test was intended for uncovering the viability of free and logical research during the time spent molding the examination capability of building college understudies inside the structure of the practical model execution. The strategies for numerical insights used to decipher the aftereffects of test study affirmed unwavering quality of the outcomes acquired. The materials of the paper can be connected by scholarly instructing abound of building colleges, teaching method, hypothesis and strategy of professional training specialists and furthermore in the postgraduation framework.

Key words: engineering university, research activity; research competence; projects method; research tasks.

1.Introduction

The world community is striving to create a global strategy for human education, which contributes to development of an international educational space with certain trends: “the transition from elite education to high-quality education for all; deepening the international governmental cooperation in education; scaling up the humanitarian component; spreading innovations without prejudice to existing national traditions and national identity of countries and regions” [14]. The vectors of engineering education in the context of solutions to the “pan-European zone of higher education” building [9] is updated. In the document of “Modernization concept of Russian education for the period between now and 2020”[7] it was noted that the main goal of higher education is the preparation of qualified specialist, competent and competitive, responsible, able to work in related fields of activity. The problem of research training for students of engineering universities is worldwide relevant also. At the World Engineering Forum in Florence WEEF 2015 “Engineering education for a stable and sustainable society”[16] organized by the International Federation of Engineering Education Societies (IFEES) it was determined that in modern conditions it is just the university engineering education that is able to produce engineers of the future, focused on carrying out engineering researches and professional surveys.

Worldwide required capacities of graduates of an engineering university, the features of modern production in Russia, the modernization of industry and the development of high technology requires the modernization of schooling of competitive experts with modern knowledge and skills, the necessary production and personal potential for working for high-tech enterprises. “The development of engineering education is determined by the task to ensure global competitiveness of the national products and only after that the imports phase-out. To do this it is necessary to significantly change the paradigm of engineering education, as well as the content structure and methods of training of engineering personnel”[13]. There is a growing need in the world for competitive engineering personnel willing to actively participate in innovative engineering processes, developing new ideas, solving research problems, thinking non-standard, capable of taking non-standard solutions and exhibiting research behavior. Future engineer is a research engineer. All this requires fashioning of research competence of students of engineering universities who can effectively implement professional competencies in activities and find independently solutions to non-standard engineering tasks.

2.Research Methods.

Theoretical (learning, analysis and synthesis of didactic, social, engineering, economic literature on the problem in question, analysis of the subject of the study, modeling educational process, generalization of the research

results); empirical (study of regulatory acts, observation, interviews, testing, self-assessment, documentation analysis, study of product activities, pedagogical design); experimental (pedagogical experiment, methods of mathematical processing of results).

3.Results and discussion of the results of the study.

3.1.Analysis of existing approaches to solution of the problem of student's research training at engineering university

The issues of qualitative improvement of the preparation for research activities of students of engineering universities are of particular importance since one of the leading tasks of higher education is the involvement of students in research activities that will "not only preserve the well-known Russian scientific schools in the world but also bring up a new generation of researchers innovations-oriented to the knowledge economy" [15].

In the process of research the authors systematized, identified and developed existing approaches to the problem of research schooling of students of engineering universities in Russia contributing to the development of the methodological foundations of this training and in particular as follows:

- preparation for research activity through motivation (O.O. Nenasheva [11], A.L. Mazaletskaya [8], I. Yu. Danilova [5], etc.); orientation to scientific knowledge of students in learning process, possibility of research assignments usage; stimulation of non-standard approaches and solutions (E.A. Grebennikova [2], A.A. Gubaidullin [4], A.A. Ermakova [6], etc.);
- employing a person-centered approach based on the students involvement in the process of active learning, development of creativity (E.P. Groshev [3], A.M. Mityaeva [10], N.I. Naumkin [12], E.M. Timofeeva [18], and others);
- orientation to self-educational activity using Internet resources, project activities (O.S.Terekhina [17], T.M. Tsunnikova [19], I.A. Janyuk [20]), and others;

The analysis of these studies demonstrates that the researchers focus on the important aspects of preparation for research activities, paying great attention to the content of engineering education and the technological component of training. But the studies do not sufficiently reflect the conceptual idea of preparing students for research, wherein specially organized measures are required and a significant potential in improving the quality of professional education remains; research activity is not considered as a basis for the formation of general cultural and professional competences with the purpose of realizing the requirements of Federal State Higher Educational Standard(FSHES), and consequently the preparation for research activities is not studied in the view of building innovative didactics of engineering universities; the issues of changing the quality of the management system of education are not paid proper attention to; the issue of organization of the developing educational environment of the university is not touched upon. Besides, no close connection between the university and future employers, their participation in the process of preparing students for research activities can be observed [25].

The study of foreign experience enables to identify a number of provisions that the authors took into account when preparing students of an engineering university for research: application of special courses; learning and implementation of heuristic methods; implementation of research assignments and projects; development of industrial design skills, aesthetic development of students; education of ethics, which are presented in the works of R. Arden [21], W. Baumol [23], M. Baxter [22], A.Daemmrich [27], M. Kogan [28], and others.

In the process of systematization, analysis, interpretation and development of existing approaches in new educational and socio-economic conditions, given the specifics of engineering activities, FSHES requirements, professional standards, employers' needs, the authors believe that the preparation for research has a significant potential in improving of quality of engineering education.

This is the provision for need and expedience of creation and implementation of a coherent concept of research schooling of engineering university students through the functional model.

3.2.Organization of independent and scientific research of engineering university students

When implementing the model of research training for students of engineering universities [1], special attention is given to the independent work of students designed to ensure the effective assimilation of the experience of research and its content, to provide students with opportunities for self-realization, self-organization, self-education, self-development. The types of independent surveys are classified according to the level of independence of students' activity, ways of monitoring and evaluating of its results:

1. independent survey performed individually by assignment;
2. out-of-class independent work to solve a problem proposed by the teacher or independently by a student (preparation of abstract, report, development of experiment, etc.);
3. study and research (work on the project, writing course, final qualifying dissertation);
4. student research with the results in the form of a report, a conference report (thesis), a patent.

The singularity of the students' independent work was that these studies were based on independent activities. The teaching in these conditions represented active independent researches: reading and analysis of literatures, abstract reading; solving problems of different complexity; performance of laboratory and practical works, implementation of projects, cross-sectional research assignments, etc.

The authors proved the legitimacy and expediency of employing creative tasks intended primarily to organize individual work of a trainee. The peculiarity of performance of these tasks was that they required the search, study,

analysis, generalization, systematization of additional information, a longer time for preparation, and therefore were carried out at extra-auditor time. Thus, an important condition for fashioning of research competence of engineering universities students was the organization of extracurricular independent researches and surveys (NIRS).

Initiative groups were created at the academic departments and the students were involved in it free-will. Participation in the work of initiative groups contributed to the satisfaction of students' needs for enhanced study of the material, developed research thinking, promoted the formation and improvement of research skills, and, accordingly, the formation of research competence. Students performed tasks of a theoretical and practical nature. Projects were carried out individually and collectively.

The groups started working from the first academic year (from the 2nd semester) within various directions depending on the interest of the students. Teachers helped in choosing the subjects of survey (taking into account the preparedness of students and their propensities), guided and provided assistance. Students were asked to perform tasks of both theoretical and practical nature. They reviewed and summarized scientific literature, other sources of information, and conducted experimental work (whenever possible). Working in the initiative groups made a free choice of creative research development possible.

In the first year the results of the work were reported at the meetings of the initiative group of the department with the invitation of the teachers of the department, representatives of the basic enterprises. The students delivered reports on the results of the work done. In upper grades the work of the initiative groups was not only individual, but also collective projects developed as continuation within the framework of a single research program. The implementation of the program was carried out by methods, which shared all participants. This approach enabled the combination of variability and universality, since the methods of research and knowledge were gained in different sciences.

The form of the final accountability of the work of the initiative groups was the annual scientific and practical student conferences and seminars, as well as international conferences held at the university (compendiums with theses and reports were published as a result). Conferences and seminars motivated: interest in research; increase of creative activity; engagement more students in research tasks; formation of self-education, self-improvement and self-realization skills. Representatives of basic enterprises were invited to participate in conferences and seminars as experts. The contents of assignments were coordinated with them. The analysis of the studies proved that the students gained experience of research activity [1].

The spirit of competition in student body was a powerful stimulus for the development of interest in researches. The results of solution to the research problems and speculations while compared with the data of the experiments demanded an explanation of the mechanisms of transformation of the studied phenomenon into new qualities. Independent preparation of abstracts and reports at the conference, analysis of research projects and the studies of other students, observation of their creative and exploratory activities proved the acquisition of research experience.

When performing assignments the students not only expanded and deepened their knowledge, developed research skills, but also formed the ability to consistently and clearly lay out the essence of the issue, the ability to express themselves in public speaking (i.e. overcoming the lack of emotionality, monotony of speech), the ability to take into account the pluralism of opinions and show understanding, the ability to establish contact with the audience, the ability to control oneself in public speaking (overcome excitement, etc.), the ability to exit from contact (avoidance of jumbled speech and incomplete performances). Very effective in terms of development of motivation and acquisition of experience in research activities was the attraction of students of junior courses to attend conferences. This motivated them to present the results of their own research developments.

An important point was the creation at engineering university of a developing educational environment as the indispensable condition for the solution of the task of creating innovative didactics of an engineering university focused on research preparation for research activity of a graduate, who is characterized by an individual and productive style of engineering activity. The educational environment, as a competency-oriented space, includes a spatially-objective, substantial organizational, information component that provides optimal educational activity of engineering university in the process of students' research training. The organization of the developing educational environment of an engineering university provides for: motivating students to get ready for research; interaction and joint activity of all subjects united by the environment space (students, teachers, university employees, representatives of basic enterprises); self-regulation of preparation for research activity [25].

The scientific seminars resulted very fruitful to form practical experience of research activity. The university teachers, students, representatives of basic enterprises took part in these events. All participants were united by interest in the specific research problem, related information, presence of a certain individual research experience. Such seminars allowed the participants to systematize information on the state of the problem, taking into account Russian and overseas experience, the state of affairs in the region and the city; coordinate positions, correct objectives, determine the best ways to solve identified research problems. The students independently chose the direction of search and target result of their participation in the seminar (report, article, essay, project, etc.). Each participant felt involved in the common cause, responsible for their work. The students were stimulated intellectually and psychologically, motivated for research. The ambiance of seminars facilitated healthy competition.

The annual visit to the International Exhibition "Achievements in the Oil and Gas Industry" was research motivating. The students could there clearly see the latest innovative developments both in the field of technologies and equipment for the oil and gas sector, could communicate with the representatives of scientific communities, enterprises not only the city, the county, but the whole of Russia and internationally. Participants of the initiative groups annually issued a stand "Innovations of students of the Tyumen Industrial University", which served as a powerful motivational factor to attract students to researches.

An important form of research training for students was the execution of a term paper and final dissertation (FD). The corrections were made to the guidelines, with emphasis on preparing for research in order to successfully complete course work, projects and FDs by the students (guidelines, assignments posted in the electronic system of support for the educational process of Educon) [24].

The application of the project method in the formation of research competence among students brought positive results. The authors used different types of projects: information, research, performed on the instructions of the teacher. As for the duration of implementation they were short-term (the development of a plan for solving a specific research problem and its presentation fit within the framework of one academic lesson); medium-term (two to three weeks) and long-term (more than a month, semester, academic year). The latter were applied during different types of practice, in the performance of research assignments, term papers, in the work of initiative groups.

The student's projects, which were filled with practical-oriented subject content enabled to apply the knowledge gained during the training and served as a kind of the balance of interdisciplinary integration, acquired knowledge, mastered research methods and formed research skills. This type of work allowed students to develop self-management skills, endurance, diligence, planning, tolerance for critics, work in diversified groups, and the ability to evaluate the merits of other research projects.

Filled with a practical-oriented substantive content, students' projects were focused on the integrated application of the formed competencies, mastered skills and research activities. As part of our study, we used cross-cutting, integrated (interdisciplinary) projects of an integrative orientation. (For example: "Analysis of the effectiveness and prospects for the application of enhanced oil recovery methods at the Fedorovskoye oil deposit"; "Evaluation of the efficiency of geological and technological measures at the Zapadno-Surgutsky deposit"; "Preventing cone formation in high-water fields", etc.). An important criterion in organization of students' work was the presence of a significant research task, requiring an integrated research search for its solution; practical, theoretical significance of the results of its solution; structuring the content of the project, indicating step-by-step results; different research methods implementation. It should be pointed out that there were few such works, they were mainly developed by the initiative groups participants.

In the process of realization of the functional model of research preparation for students of engineering universities, the dynamics (from year to year) of increasing interest in the execution of coursework (projects) was outlined, which contributed to improving the quality of their implementation and presentation of defend results of dissertation. The possibility to dedicate long enough time for chosen scientific research area contributed to the fact that by the time of final qualifying dissertation the students had a thorough knowledge of theoretical information, had solid empirical material, and mastered a variety of research methods. Thus, the FD accumulated all the research experience acquired by the students, which affected the quality of its performance. The use of complex research projects, cross-sectional research assignments proved to be most effective in the execution of FDs (themes of the work were associated with the research activities of the departments and with the requests of concrete industry sector). Long work on a certain topic and area contributed to the fact that FDs accumulated all the research experience acquired by students, which impacted the quality of its implementation.

The analysis of FDs in experimental groups showed that their essays singled out with a clear research plan, and therefore the consistency of the research activities; specificity of requirements to the results obtained; research orientation; accuracy of choice of the diagnostic tools; methods of processing data and information. The authors noted an improvement in the quality of research in the experimental groups in the course of the execution of course projects (assays), as well as in the implementation of FDs performance. Table 1 shows the results of the execution of coursework (projects) and the final dissertation defence in 2016 [1].

Table 1 Results of the execution of FDs (2016r.) and course works (projects)

Rating	FDs,%		Course works (projects),%	
	Experimental groups	Controls	Experimental groups	Controls
5 (91-100 points)	60	15	50	20
4 (76-90 points)	32	65	40	50
3 (61-75 points)	8	20	10	30
2 (less 60 points в)	-	-	-	-

Particular attention was given to the application, consolidation and improvement of the experience of students' research activities, attitudes towards it during the period of internship. All kinds of internships served as one of

the leading factors in fashioning research competence of students since the essential aspects of the engineering as profession manifested very clear when in the internship period.

The assignments when organizing and conducting the internship were designed to find solutions to real workplace issues, which facilitated the students' mastery of the research methodology. Organization of the training internship (1st university level) assumed that the students should master the methods of empirical research (observation, conversation, summarizing the results, keeping protocols, etc.); operations of analysis, comparison. The first workplace internship (the 2nd level) included: study of research engineering experience of enterprise employees; development and implementation of activities within the internship plan; solution of real research problems. The second workplace internship (3rd level) was meant to specially organize the work of students on research topic, which facilitated the transition to real research assignments in the workplace situation. During the internship the students performed assignments that were coordinated with employers. Engagement in practical job assumed the implementation of research in engineering activities. As a result 83% of students FDs topics were associated with the studies executed during the internship period.

All types of the internship facilitated increasing of research activity of students, development of research skills, acquisition of individual research experience and ability to independently discover the studied phenomena. The author's approach was meant to teach the students how to determine the correct course of the task even in non-standard situations that were prepared in advance, but were completely unexpected for a trainee. It urged him to reorganize his activity plan, change criterion for the result, search for another methods, etc. This allowed the ability development of students to dynamically contemplate and act in unusual situations.

During the implementation of the model of research training for students of engineering universities (2010-2016) the authors monitored the employment of graduates. It can be stated that the targeted schooling of students for research activities contributed to the greater satisfaction of employers with the quality of graduate training. Representatives of basic enterprises, which took direct part in the learning process, got more interest in the research oriented students (in the process of working on research assignments, projects, presentation of work results, etc.). During the internship period many students showed activity, interest in solving real production problems, demonstrated readiness for self-improvement in the future profession. This helped to attract the attention of the enterprises representatives, as a result of which the number of graduates finding employment at the place of practical training increased every year. In addition, the motivation of students to continue their studies in the magistracy increased. (Table 2) [1].

Table 2

Table 2 Job placement of graduates in oil and gas sector

Year	Basic companies OJSC "CNG", OJSC "Nefteservice-Nord", OJSC "Gasprom-Surgut"		Close Oil Corporation «LUKOIL», LLC "NOVATEK" OJSC "Rosneft", and others	Private oil&gas companies	Full-time magistrate	No job in "Oil and gas sector"
	Internship location	Others subdivisions				
2010	35%	15%	25%	5%	5%	15%
2011	35%	15%	25%	5%	10%	10%
2012	37%	15%	20%	8%	5%	15%
2013	45%	20%	10%	5%	10%	10%
2014	60%	10%	10%	5%	10%	5%
2015	65%	5%	5%	5%	15%	5%
2016	70%	5%	5%	5%	15%	5%

However, it should be noted that the questions of employment are very capacious and multifaceted and depend on a number of objective and subjective factors. So the authors in the paper just acknowledged the percentage of employment, made an attempt to associate the number of employed graduates with the process of the target research training of engineering university students.

The peculiarity of the functional model of research training was the creation of a portfolio by students as a set of works reflecting the dynamics of the students' development through the presentation of diverse activity results. The Portfolio is a tool for self-presentation of a student, which contributes to self-organization, self-development and reflection.

The control-effectiveness component provides the teachers supervision over the process of fashioning the research competence of the students and, if necessary, adjusting it, as well as students' self-control. Wherein the self-control function is gradually amplified, acquires a conscious, strong-willed character and research activity becomes more meaningful. The supervision is carried out by the following methods: testing (the Educon system), questioning, checking, tasks and projects defence, systematic monitoring of student activities [26]. For the effectiveness of self-analysis, self-monitoring, and self-evaluation by students of the process and the results of research activities it is provided: familiarity with the criteria for the effectiveness of research activities; methods and ways of control and self-

control (questioning, testing, ranking, self-assessment, observation); formation of skills of analysis and evaluation of one's own actions; access to the rating indicators. A feature of monitoring and evaluation in the model are: the variety of forms of intermediate and current control; students' choice of the form of the final report on the results of activities; use of pedagogical diagnostics, which allows to forecast possible deviations and make corrections.

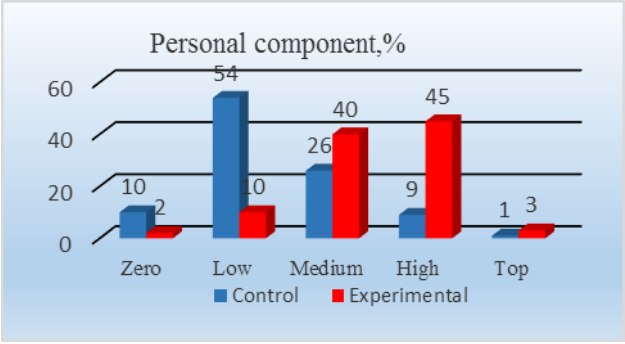
3.3.Results of experimental work on the fashioning of research competence of students in the process of independent and scientific research

As components of research competence, the authors identified: cognitive, personal, activity, which served as criteria. The dynamics of the formation of research competence of students of engineering universities is presented in Table 3 [25].

Table 3 Dynamics of the formation of research competence of students, %

Personal component *Motivational*	2012-2013 acad.year.		2013-2014 acad.year.		2014-2015 acad.year.		2015-2016 acad.year.	
	Experimental	Control	Experimental	Control	Experimental	Control	Experimental	Control
Top	0	0	3	0	3	1	3	1
High	0	0	27	2	37	3	45	9
Medium	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
Reflective								
Top	0	0	3	0	3	1	3	1
High	0	0	27	2	37	3	45	9
Medium	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								
Top	0	0	3	0	3	1	3	1
High	1	0	25	4	38	7	50	19
Medium	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								
Top	0	0	3	0	3	1	3	1
High	0	0	26	1	42	1	49	9
Medium	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

Figure 1 represents the final condition of students' preparedness of the experimental y control groups.



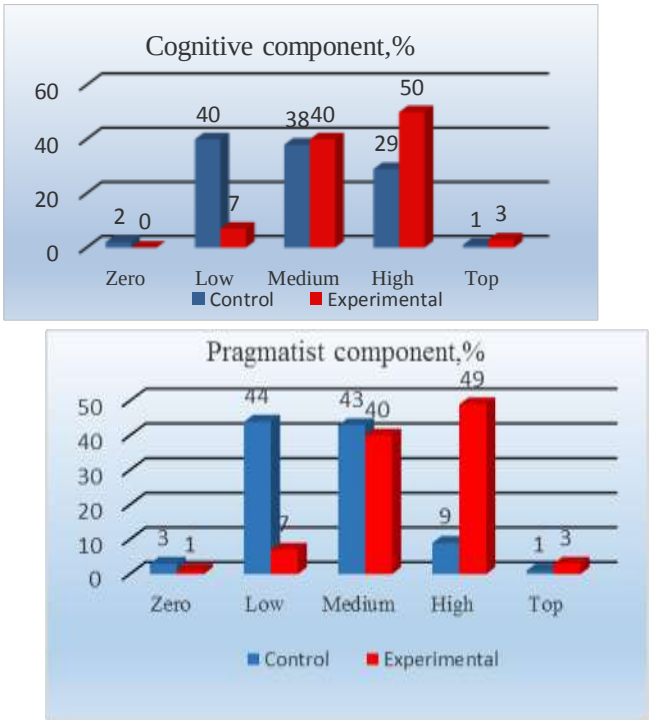


Figure 1 Formation of components of research competence of students

The analysis of the results of experiments, comparison of the experimental and control groups showed the effectiveness of the functional model of student research in the context of competence-oriented engineering education. The assumption of the effectiveness of the use of independent and research work affecting the process and the result of the formation of research competence was experimentally confirmed. Changes in the experimental groups are stable in all components. Students of experimental groups demonstrated statistically significant changes in the levels of formation of all components of research competence and these differences are statistically significant in comparison with the reference results of control groups. The verification based on statistical analysis using the criteria of mathematical statistics by Pearson's chi-squared test confirmed the validity of the results

4.Conclusion

Research training aimed at the formation of an engineer, which would be characterized by the individual and productive style of engineering activity determines the formation of research competence as a developing integrative personal characteristic that provides an active research position in relation to activity and to itself as its subject in the conditions of development and operation of innovative engineering technologies and productions. The schooling for research (as an obligatory quality of the implementation of the requirements of educational standards) ensures a value-based attitude to research; the ability to identify information failure and at the level of active learning new knowledge needed to solve research engineering problems; the ability to plan and conduct research, to collect data, process them and interpret the results.

The results of experiments show the effectiveness of the process of forming the research competence of students in the process of independent and research work within the framework of the developed functional model of research training for students of engineering universities. At the same time, the developing educational environment is provided; the students are motivated to research, develop their subjectivity, and create an atmosphere of productive activity. The structuring of the content of education, implementation of interdisciplinary integration, engagement in vocational training of special courses, targeted internships; creation of special out-of-class forms and means of activities together with representatives of the base enterprises are carried out. The application of networked educational resources, system of tasks, which are relevant for professional engineering activity is developed and used in the process of purposeful training of students in the course of their implementation. The reflection and self-control of students are also developed.

4.1.The theoretical significance of the study is that:

- the theory and methodology of vocational education are enriched with knowledge of the essence of the process of fashioning of the research competence of students in the process of independent and scientific research in the educational process of an engineering university;

- within the context of innovative didactics of an engineering university represented in the form of a functional model, the independent and research work of students is considered as an indispensable condition for student research, which ensures the development of students' creativity, their research abilities, the formation of functional research skills as universal means of contact with the outside world .

- independent and research work performed by the developed practice-oriented methods, special forms and means of out-of-class activities; information technologies, network educational resources; a system of tasks, integrated, cross-cutting research projects, interactive forms and methods; self-monitoring and self-assessment of students in the process of training – all these are an integral part of the developed and experimentally tested functional model of schooling students of an engineering university for research activities that provide for the organization of the developing educational environment of the university.

4.2.The practical significance of the study is that:

- developed and approved functional model of preparing engineering students for research activities, an integral part of which is independent and research work; the model can be used in the practice of basic and additional engineering education with the aim of increasing the effectiveness of forming a competitive graduate;

- recommendations for the organization of independent and research work for the teaching staff of the engineering university, taking into account the requirements for the level of readiness of the teaching staff for the implementation of this process; the recommendations can be applied in the system of professional development of teachers of engineering universities.

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