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DIDACTIC SYSTEM FOR IMPROVING THE STUDENTS' RESEARCH ACTIVITIES

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The article is aimed at improving the quality of vocational training for students majoring in oil and gas engineering in the process of enhancing the students' research activities on the basis of educational, scientific and industrial integration. The students' research activities contribute to the gradual development of their scientific technical creativity. Having analyzed foreign and domestic theoretical and practical experience, the authors proposed a methodology for assessing the effectiveness of students' participation in all forms of research activities integrated into the learning process and complementing the learning process. The ways to enhance research activities were suggested in the article. Network interaction with employers is implemented at the branch of the Tyumen Industrial University. The systemic educational and research work is one of the most important directions in the formation of a science-oriented educational environment at the university, the implementation of which in the teaching and upbringing process is one of the main conditions for improving research activities at the university.

Keywords: higher education, students' research activities, learning process educational environment, network interaction

INTRODUCTION

A high level of science-intensive professional activity of specialists necessitated the formation of a scientifically oriented educational environment that activates innovation activity. At the same time, systemic research work is one of the most important directions in the formation of a scientifically oriented educational environment; in the process of this work a new generation of research specialists is being formed who are capable of working in an innovative, prognostic mode in the conditions of a high level of science-intensive professional activity.

In the practice of modern education in the United States, Western Europe, the variative forms of organization of students' scientific research activities have traditionally been developed and are actively used: scientific propaedeutic courses and proseminars (Germany); research projects (Germany, the USA); problem-oriented courses (England, Germany, France); project technologies in small research groups (the USA).

The article by N. Yurko (2000) reveals the features of the higher education system in Scotland. There are two postgraduate programs in the country. "Taught"

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is similar to the Russian version; it includes lecture classes, seminars, passing of intermediate exams and tests. Unlike the first program, “Research” is designed for people conducting scientific investigations, the basis of which is the joint work with the scientific adviser. The author states that recently in the West the programs of distance learning have become very popular.

In Germany own specificity is inherent in the scientific activity system in higher education. E. Frank and C. Opitz (2002) note that the problems of increasing the competitiveness of the university system are actively discussed in the country. Politicians agree that by reforming Germany’s higher education, it is necessary to create such a system of training highly qualified specialists that will be able to function effectively in the conditions of fierce competition. The authors of the article propose to radically change the structure of the educational services market in Germany. Forming a hierarchy of universities will force them to engage more in ‘reputation management’ in order to attract the most capable students and be able to conduct research at a high level.

The organization of the educational process at German universities differs in the so-called ‘research training’, introduced from the late 1960s and fully justified, the essence of which is that a senior student who has shown the ability for scientific activity is awarded the title ‘student-researcher’ and is given the theme of the dissertation research rather than graduation thesis. Such training must end with the dissertation defense. At this time, students study according to an individual learning plan, form research teams and sections, have a scientific adviser. The so-called ‘signs’ of the student-researcher are developed: the ability to generate scientific ideas, knowledge of foreign languages, perseverance in solving scientific problems, the ability to work in a team, the desire for publications, interest in scientific issues of related disciplines.

In the practice of the German higher school, specific forms of encouragement for highly gifted students are being successfully implemented in the form of experimental circles for the training of highly qualified personnel: ‘rector reserve’, ‘master classes’, ‘research cadres for industry’, ‘high-performance new scientific generation’. The conclusion of an agreement between the rector and each participant is an obligatory condition for working in such teams.

New complex forms of scientific cooperation of universities with leading industrial associations are developing and become widespread: temporary research groups, so-called ‘application groups’, consulting centers, cooperation in joint scientific commissions, methodical and diagnostic centers, student scientific technological centers in the framework of interdisciplinary scientific research and much more.

The experience of the US universities in the organization of research work of students is of great interest; there, in addition to the universities, the manufacturing enterprises or firms playa large role. Thus, T.S. Georgieva (1988) analyzed the experience of the US universities on interaction with industrial enterprises, and, among other things, considered the role of student science in this process. In recent years, in the US the tendency has clearly defined for a wider participation of private firms in financing university research, and the cooperation between universities and industry is steadily developing. Usually, the cooperation begins with the fact that firms use university scientists as consultants in conducting their own research. Then a contract for joint work is concluded. Recently, the number of design institutes has been growing which operate independently from the university administration of research organizations employing teachers, students and graduate students. Such organizations enable students to start scientific research even in junior courses, and then continue them at the stage of graduation, and further in the status of graduate student and a research instructor. Another promising form of contacts between universities and industrial enterprises in the conduct of scientific developments is research and scientific parks, the main purpose of which is to implement scientific research of student youth and to support perspective scientific research of students.

The research work of students at the universities of the United Kingdom is the basis for the subsequent scientific postgraduate training. Educational programs of doctoral level at the British universities are primarily New Route PhD – integrated postgraduate programs, combining research activities with the vocational training program. Successful graduates of such programs are independent researchers, equipped with professional, personal and transferable skills that can make a significant contribution to the development of the chosen field.

The implementation of own research project takes place in close cooperation with the scientific adviser. The training module includes courses in the specialty, courses aimed at developing academic and research competencies, as well as interdisciplinary courses aimed at developing professional skills.

LITERATURE REVIEW

It is a commonly acknowledged fact that education today is not a mere transference of knowledge, it is not "the traditional lecture-based teaching model" (Prince et al. 2007), when a teacher comes into the classroom and presents material with examples on the board or in PowerPoint slides (Prince et al. 2007; Umbach 2006; Carini et al. 2006; Willingham 2009; Hu et al. 2007).

Foreign scholars speak of the necessity of a "research-teaching nexus" (Prince et al. 2007, Ramsden 2003, Csermely 2007, Research-Oriented Teaching 2017), when research is brought into the classroom, and inductive teaching becomes a dominating instructional strategy (Prince and Felder 2006, Brew 2003, Karen et al. 2015) and students' culture of receivers is transformed into a culture of inquirers (Prince et al. 2007). In this case the students are not presented with a ready-made knowledge, but with "a question to be answered, a problem to be solved, or a set of observations or experimental results to be explained" (Prince et al. 2007). Thus, education is transforming into a "research-oriented learning" which "revolves around inquisitive, problem-oriented and critical thinking, autonomous and creative working and practical application in academic research" (European University Viadrina 2017). This definition suggested by the German Ministry for Education and Research (Bundesministerium für Bildung und Forschung) demonstrates the main idea of research-oriented learning: "education through science" (European University Viadrina 2017).

Scholars pay attention to the necessity to implement the principles of research-oriented learning at different stages of high school education.

Undergraduate students are taught research principles in an introductory research methods course. Scientists distinguish a set of broad common learning objectives connected with the course: "(1) Develop the ability to define a research problem; (2) Recognize and use the appropriate techniques to collect data to address a research problem; (3) Interpret data <…>; (4) Develop the ability to effectively communicate research results both written and orally; and (5) Develop the ability to critically evaluate limitations, errors, and biases in research" (Strangman and Knowles 2012).

Different approaches are used to deliver this core curriculum course to students: as "an exercise in addressing hypothetical situations or by studying research cases", employing "a problem method where students are given a set of scenarios to analyze using a variety of research methods" (Strangman and Knowles 2012, Denham 1997), following a project-based approach, when students fulfil a research project from beginning to end (Aguado 2009, Longmore et al. 1996, Van Gelder 2001), or a lesson study approach, when study starts by formulating the goal of the learning process, and then students work to "design instructional experiences" to achieve the objective (Cerbin and Kopp 2006, Hart et al. 2011). Some scientists suggest dividing an abstract process down into its component parts and giving students the opportunity to train each of these component abilities individually (Strangman and Knowles 2012, Ambrose et al. 2010). In this case lesson development includes the following stages: defining outcomes collaboratively, modeling the process of problem definition and the use of learning tools (using a brainstorming process, a set of prompts for students, connecting related ideas and eliminating ideas that are not useful in addressing the whole problem), developing the problem definition table to visually "display the overall research problem as overarching to the specific research questions", submitting students' research proposals including a "statement of the overall research problem, as well as the research questions and hypotheses that the students had developed" (Strangman and Knowles 2012). The main idea of these approaches is that "the research process is best learned by doing" (Aguado 2009).

Different ways to make learning research-oriented are suggested by scholars from various countries:

1) connecting *teaching and scholarship*: work with teachers-scholars gaining access to relevant and up-to-date material and discussions in the corresponding fields, "public lecture series in which faculty members could share their research with the campus community", "work-in-progress" seminars to provide participants with constructive criticism during their work on new projects, discussing ideas from students' readings or classes with faculty members outside of class, working on a paper or project that require integrating skills or information from various sources; making judgments by students about the value of information or methods used by others to examine how they gathered and interpreted data for assessing the correctness of their conclusions (Student Learning 2007).

   Some scholars speak of "informal learning in science, technology", etc. (Karen et al. 2015). Canada's Natural Sciences and Engineering Research Council (NSERC) launched its CRYSTAL program in 2004 in an effort to promote research into science and math teaching at the K12 level. Educators, practicing scientists, K-12 teachers were invited to form regional interdisciplinary collaborations in order to compete for five funding streams ($200,000 yearly for five years). The projects "include encounters between students and practicing scientists in university laboratories and field studies; summer camps for science engagement; after-school science clubs for teachers and students; innovative software for computer assisted learning; environmental problem-solving in a comparative, international context; online communities devoted to solving mathematical problems; and explorations of ethonomathematics among Canadian aboriginal peoples" (Karen et al. 2015);

2) *organizing undergraduate and graduate research internships* (Nnadozie 2001); for example, a summer academy at the University of Rochester, or The **Young Entrepreneurs Academy** (Redefining Entrepreneurship 2017);

3) *having an opportunity to work intensively as part of a research group*, when students choose their research preferences from a list of available projects. Students carry out different activities, have lab experiences, and one-on-one lessons from professors (Karen et al. 2015). The Go Global program at Mount Allison University (since 2007) is an example;

4) *encouraging students to participate in annual research fairs, in regional and national forums featuring undergraduate and graduate research* (The Northern NJ Junior Science and Humanities Symposium (JSHS) held at Rutgers University and others) (Student Programs 2017, Student Learning 2007);

5) *establishing an international scientific network* (the Network of Youth Excellence (NYEX) in 2004) to promote scientific research among young students (Csermely et al. 2007);

6) *building network of universities, research institutions, school administrators and curriculum designers within one country* (in 2004 the University of Milan

(Università degli Studi di Milano) signed a collaborative agreement with the Educational School Office of Lombardy coordinating public High Schools. As the result, Cus-Mi-Bio (Centre of the University and High School of Milan for Bioscience Education) was established. To promote the life sciences, the Initiative Youth and Science was founded in Germany in March 2004, which includes currently 12 partners (Csermely et al. 2007);

7) *establishing collaborative research with partnerships from external industry and business resources* (New Jersey Institute of Technology 2017, Medical Research Programs, 2017);
8) *organizing students' research visits to industry* (Tash 2006);
9) *the availability of special Internet programs to increase interdisciplinary communication among scholars and students* (Tash 2006; Teacher Resource Center 2017; Byung-Ro 2001, Keengwe 2014);
10) *students' participation in faculty research projects* (Infusing Undergraduate Research 2015);
11) *systemic mentoring of undergraduate students* (Infusing Undergraduate Research 2015);
12) *enabling the transfer of students to, for example, four-year STEM degree programs, etc. at other institutions* (Infusing Undergraduate Research 2015);
13) *teachers' upgrading programs* (Teaching Teachers 2017).

To sum up, developing students' research abilities suggests carrying out various activities of methodical, organizational, etc. character. It helps students acquire research knowledge and skills, and have effective outcomes.

The aim of the study is to improve the quality of vocational training for students majoring in oil and gas in the process of enhancing the students' research activities on the basis of educational, scientific and industrial integration.

The research tasks include

- revealing the peculiarities of the professional activity of specialists in the fuel and energy complex, which affects the science-oriented component and dictates the need for students' research activities in the educational environment formation based on practice-oriented training and close ties with production;
- revealing the specifics of the content of students' research activities at the higher education level and identifying the pedagogical conditions that can ensure the enhancement of students' research activities at the university;
- developing technological support for the implementation of an integrative approach in all forms of students' research activities (SRA) integrated in the learning process and complementing the learning process, as well as the process of improving the qualifications of the faculty members.

RESEARCH METHODOLOGY

In the course of elaborating the methodology for trial evaluation of the pedagogical experiment results, the willingness of students to research work in conditions of a high level of science-intensive professional activity was chosen as an integrative indicator of the effectiveness of the developed technological approaches. This integrative indicator is represented by differentiated indicators: **the level of research competence** and *the level of personal contribution of students to the implementation of complex tasks, works and events of research activities*. The differential indicator of the level of students' personal contribution to the implementation of complex tasks, works and events of students' research activities allowed assessing the effectiveness of students' participation in all forms of their research activities, integrated into the learning process and complementing the learning process.

The effectiveness of the students' participation was established depending on the level, forms of event holding, large-scale involvement in the events with the help of the ranking method which allowed orientating toward the recommended rank of a particular event (Tables 1, 2).

The sequence of determining the recommended rank of the event consisted of the following procedures:

- defining the ranking criteria for events of the system of students' research activities (SRA);
- ranking the SRA events on each criterion;
- establishing conditional scores for ranking the SRA events;
- determining the amount of conditional scores for ranking of a specific SRA event;
- defining the rank of a specific SRA event.

TABLE 1: EVENT RANKING IN THE SRA SYSTEM

Criterion	*SRA event ranking*	*Conditional ranking scores*
Forms of event holding	Conferences	1
	Seminars	2
	Competitions	3
	Academic contests	4
Level of event holding	*At the level of training program*	1
	University	2
	Regional	3
	All-Russian	4
	International	5
Large-scale involvement in the events	*Up to 50 participants*	1
	51-200 participants	2
	201-500 participants	3
	501- 1000 participants	4
	above 1000 participants	5

TABLE 2: DETERMINATION OF THE EVENT RANK IN THE SRA SYSTEM

Sum of conditional scores	3	4-6	7-9	10-12	13-15
Event rank	1	2	3	4	5

This sequence made it possible to determine the rank of any mass and competitive scientific and technical event of the system of students' research activities in accordance with the additional personal results of students which were a differential indicator of the level of the students' personal contribution to the performance of the entire set of tasks, works and activities. The differences between the samples of the control and experimental groups by the level of the students' personal contribution to the implementation of the entire set of tasks, works and activities were evaluated using the Rosenbaum Q-criterion.

When determining the level of research competence that enables to identify the appropriateness of knowledge, skills and capacities of future technical specialists of the middle level to the actual level of complexity of the tasks performed by them in research activities, the generalized professional knowledge skills and capacities were assessed enabling to:

- study individually technical objects in the modification that is unknown to students;
- design technical objects at the level of design intent;
- design the optimal engineering process;
- troubleshoot faulty manufacturing equipment.

TABLE 3

Groups	*Samples*	*Level*			
		Low	*Satisfactory*	*Sufficient*	*High*
		Self-studying technical objects in the modification unknown to students			
Control	$\Pi_1 = 150$	Q_{11}=35	Q_{12}=59	Q_{13}=46	Q_{14}=10
Experimental	$\Pi_2 = 150$	Q_{21}=25	Q_{22}=32	Q_{23}671	Q_{24}=22
		Engineering technical objects at the level of design intent			
Control	$\Pi_1 = 150$	Q_{11}=43	Q_{12}=52	Q_{13}=33	Q_{14}=12
Experimental	$\Pi_2 = 150$	Q_{21}=12	Q_{22}=43	Q_{23}=50	Q_{24}=45
		Designing the optimal engineering process			
Control	$\Pi_1 = 150$	Q_{11}=28	Q_{12}=54	Q_{13}=50	Q_{14}=18
Experimental	$\Pi_2 = 150$	Q_{21}=15	Q_{22}=36	Q_{23}=64	Q_{24}=35
		Troubleshooting faulty manufacturing equipment			
Control	$\Pi_1 = 150$	Q_{11}=31	Q_{12}=64	Q_{13}=47	Q_{14}=8
Experimental	$\Pi_2 = 150$	Q_{21}=20	Q_{22}=46	Q_{23}=53	Q_{24}=29

T_1 (observed) = 16.7, i.e. T_1 (observed) > $T_{critical.}$
T_2 (observed) = 40.85, i.e. T_2 (observed) > $T_{critical.}$
T_3 (observed) = 44.2, i.e. T_3 (observed) > $T_{critical.}$
T_4 (observed) = 16.7, i.e. T_4 (observed) > $T_{critical.}$

To assess the development of research competence, formed on the basis of an integrative approach, a non-parametric criterion χ^2 (chi-square) was used, which, on the whole, tested the hypothesis of the effectiveness of the technological approaches developed in the study to improve the students' research activities.

The above data provide sufficient grounds for rejecting the null hypothesis (null hypothesis: the level of formedness of the students' professional knowledge and skills in the control and experimental groups after the teaching experiment is the same). This enables to draw a conclusion that a higher level of the students' research competency in the experimental group is determined by the developed technological approaches for improving the scientific and research activity of students.

Based on the results obtained, which were processed using mathematical statistics methods, the positive dynamics of differential indicators of the formed readiness to research work in students of experimental groups under the conditions of a high level of science-intensive professional activity has been proved. In general, this supports the hypothesis about the effectiveness of the developed technological approaches to the improvement of students' scientific and research activities on the basis of training, research and production integration.

RESEARCH RESULTS

As the best foreign experience shows, **the students' research activities integrated into the learning process and complementing it** contribute to the gradual development of scientific technical creativity of students.

The authors suggest the ways to enhance research activities (Table 4).

TABLE 4: THE BASIC DIRECTIONS OF PERFECTION OF STUDENTS' RESEARCH ACTIVITIES

No.	*Unit name*	*Basic directions*
1.	Background unit	1. Use of professional knowledge in solving various industrial problems based on innovative methods in the fuel and energy complex. 2. Technological complication of manufacturing processes, dictating the need to form a science-oriented educational environment.3. Search for didactic equivalents, reflecting the social experience of scientific and industrial activities and complying with the requirements of manufacturing innovations in the fuel and energy sector.
2.	Goal orientation unit	1. Study of vocational training of specialists in the oil and gas industry for the conformity of this training to the dynamism of science and technology, conditioned by modern trends in the scientific and technical process in the fuel and energy sector. 2. Integration of the educational and research activities of the university into a single process.

contd. table 4

		3. Updating the content of education which assumes the formation of a new generation of research specialists capable of working in close integration of science and production in the fuel and energy sector.
3.	Unit of conceptual provisions	1. A systematic approach to designing a system for improving the students' research activities in the oil and gas sector. 2. Practice-oriented approach to learning. 3. Realization of organizational and activity, contensive, technological aspects of educational, scientific and industrial integration as a basis for improving the research activities of university students. 4. Accounting for the training philosophy as general guidelines for educational activities, linking theoretical research and practice. 5. Transition from the technological approach to the exploratory one.
4.	Content characterization unit	1. Adaptability of the content of vocational training of bachelors in oil and gas engineering to the cutting-edge innovative transformations in the science-intensive oil and gas industry. 2. The system for selecting the content of continuing education of the teaching staff for the SRA improvement at the university. 3. The variability of the educational activity enabling to improve the SRA system, to initiate the voluntary exploratory and research activities of students and teachers. 4. Educational, scientific and industrial integration as a basis for implementing a practice-oriented approach to the vocational training of oil and gas specialists.
5.	Methodical specifics unit	1. Continuity and succession of professional training of future bachelors in the system of special courses under a single problem. 2. Creation of an informational and didactic basis for the improvement of the SRA at the university in the direction of: 1) researching the scientific and methodological framework for the research implementation; 2) organizing the students' work of in the scientific field; 3) studying the technology of working with scientific information arrays; 4) using computer and other means of computer technology; 5) improving the practical component of research; 6) preparing and publishing students' scientific papers.
6.	Activity-based unit	1. Designing a science-oriented environment at the university. 2. Improving a) SRA integrated into the learning process; b) SRA complementing the educational process. 3. Training of pedagogical personnel capable of combining pedagogical activities with scientific research. 4. Developing mechanisms for network interaction in the 'science-education-production' system through so-called targeted regional projects, administrative and organizational structures, and public-private partnership.

contd. table 4

7.	Unit of knowledge, skills and capabilities	1. Implementation of innovations, mastering the fundamentals of scientific and technical creativity. 2. Transformation of scientific knowledge in the field of well drilling into the training one on the basis of various forms of integration of scientific and educational processes, including oil and gas production; field control and regulation of onshore and offshore hydrocarbon extraction; pipeline transportation of oil and gas; underground storage of gas; storage and marketing of oil, oil products and liquefied gases; maintenance of vehicles, transport-technological machines and equipment in oil and gas production.
8.	Unit of psychological and pedagogical conditions for the development of creative personality traits	1. Psychological and pedagogical complex for developing general competencies in the vocational training of oil and gas producing specialists to work in the new conditions of Arctic development. 2. Studying the basics of psychology and scientific technical creativity in the process of improving the qualifications of the faculty members at the university.
9.	Staffing support unit	1. System of improving the SRA as an educational space for the oil and gas bachelors' training, combining a high level of fundamental training and experience in research and production activities in the areas of the oil and gas industry. 2. A bachelor-researcher's training for science-intensive oil and gas production, accompanied by research activities as a resource for the development of creative activity of the individual on the basis of deep integration of education, science, production and culture.

When developing the system for improving the research activities of students, the best foreign experience of the US universities was taken into account, emphasizing the close relationship between education and production process in the students' research work. The experience presented in foreign literature makes it possible to clearly distinguish the tendency of broad involvement of various companies in financing research in higher education, which further promotes close cooperation between the universities and industry.

Taking into account the accumulated foreign experience of universities in organizing the research work of students learning at the branch of the Tyumen Industrial University (TIU) of Noyabrsk town, Russia, network forms of research work are being actively applied during implementation of the scientific direction "Technique and Technologies of the Fuel Energy Segment, Including Field Development, Transportation and Storage of Hydrocarbons". Within the network interaction with enterprises of the fuel and energy complex of the Yamal-Nenets Autonomous District (Noyabrsk Service Technology Company LLC, NoyabrskNeftegazAvtomatika LLC, Gazpromneft-Noyabrskneftegaz OJC, etc.), which carry out well drilling; oil and gas production; field control and regulation of onshore and offshore hydrocarbon extraction; pipeline transportation of oil and gas; underground gas storage; storage and marketing of oil, oil products and liquefied gases; maintenance of vehicles, transport-technological machines and equipment in oil and gas production, educational and scientific-industrial integration in the process of professional training of oil and gas students is implemented at the branch of TIU in Noyabrsk.

Thus, within the framework of network interaction with employers in 2015-2016, the following scientific and practical seminars were held at the branch of the Tyumen Industrial University in Noyabrsk:

1. Maintenance services rendered to the oil and gas industry enterprises.
2. Alternative technologies for repair and insulation works in the oil and gas sector.
3. Backfill materials for well fastening and remedial cementing.
4. Study of multi-stage hydraulic fracturing by tracer (indicator) methods.
5. Training of professional staff in the structure of higher education in the context of an innovative strategy for the development of the Far North and the Arctic shelf.
6. Methods for enhancing reservoir recovery rate.

Educational, scientific and industrial integration is reflected in the following types of the students' research activities, namely: 1) *research activities integrated into the learning process*; 2) *research activities complementing the learning process*.

The created informational and didactic basis enabled to implement the main directions of educational and scientific-industrial integration in the students' research activities integrated in the learning process (elements of scientific research at the lectures, hands-on seminars, laboratory practicals, on-the-job training, course and graduation project development), to consider inter-scientific problems of industrial nature in the students' research activities complementing the educational process (a system of special courses concerning a single problem, and research and practice seminars).

The mechanism for regulating the students' research activities integrated in the learning process consisted in a systematic review of the curricula composition and the content of academic programs. In the complex plan for organizing the students' research work in the oil and gas industry, the *research activities integrated into the learning process* included the following areas:

1. Oil and gas field equipment.
2. Well productivity management.
3. Methods for field exploitation control.
4. Drilling of oil and gas wells.
5. Backfill materials for well fastening and remedial cementing.

6. Alternative technologies for well repair.
7. Physicochemical aspects of the drilling fluid properties regulation.

Continuous, step-by-step formation of students' creative abilities and skills in research work was a special feature of the end-to-end program for involving students in scientific research for the entire period of study. All these factors dictated the need to use such forms that allow carrying out the creative orientation of the research specialists' training continuously, throughout the entire period of study by means of predominating independent (not typical) **research project tasks with the increasing level of complexity**, when the conducted studies can be much larger in volume and more profound in content, since students are attracted to research work from junior courses.

The inter-scientific problems of an industrial nature in the students' research activities complementing the learning process were also considered through a system of special courses concerning a single problem, in the following areas:

1. Alternative technologies for repair and insulation works in the oil and gas sector.
2. Physicochemical aspects of the drilling fluid properties regulation.
3. Methods for enhancing reservoir recovery rate.
4. Application of hydraulic fracturing in horizontal wells when developing low-permeable seams in Western Siberia.

A system of special courses concerning a single problem for majoring in Oil and Gas Engineering, profile: "Operation and Maintenance of Oil Production Facilities" is given as an example in table 5.

The design of the students' research and development system on the basis of educational, scientific and industrial integration also included a direction related to the faculty members' professional development ensuring their continuous updating of the scientific knowledge in advanced technologies in the fuel and energy sector, the study of modern technologies for scientific and educational work, the study of modern pedagogical technologies, mastering the techniques of the new university management, including new approaches to providing the educational process quality. Formation of the space initiated by voluntary exploratory and research activities that involve the solution of important production problems in the framework of targeted projects dictated the need to create the necessary conditions for improving the level of training, retraining and advanced training of the teaching staff in the process of organizing and functioning of the students' research activities. Advanced training is carried out in the branch on the basis of leading universities of the country, advanced training institutes, inter-branch regional centers for advanced training and retraining of personnel in the Russian Federation, and at the leading enterprises of the industry.

TABLE 5: A SYSTEM OF SPECIAL COURSES CONCERNING A SINGLE PROBLEM FOR MAJORING IN OIL AND GAS ENGINEERING, PROFILE: "OPERATION AND MAINTENANCE OF OIL PRODUCTION FACILITIES"

No.	*Development and operation of oil and gas fields*
1	Analysis of the efficiency of applying technologies to control a field facility development
2	Efficiency evaluation during the field disaggregation of operational facilities
3	Assessment of residual reserves for the field facility and activities for their involvement in the development
4	Rationale for technological indicators during implementation of various flooding systems at the field facility
5	Rationale for measures to finalize the facilities at the final stage
6	Analysis of hydrodynamic models for the forecast of the field facility development
7	Assessment of technological efficiency due to the introduction of methods for bottom-hole zone treatment of the field facility
No.	*Borehole oil production*
1	Rationale for the operation modes of the watered well stock of the field facility
2	Rationale for measures to improve well operation modes with sucker rod pumping unit in the reservoir layer
3	Improvement of the insulation works efficiency at the field facilities
4	Efficiency analysis of the return to the upper horizons of the field
5	Development of measures to combat paraffin deposits in the deposit wells
6	Rationale for the technological modes of operation of wells with horizontal endings in the field
7	Hydrodynamic methods for bottom-hole zone treatment in the field conditions (in case of experimental data available)
8	Selection of equipment for the exploitation of the field facility
No.	*Collection and preparation of production fluid*
1	Improvement of the field oil-water-gas collection and treatment system
2	Efficiency analysis of using reagent-saving technologies in field oil treatment
3	Rationale for the field collection system reconstruction
4	Technology optimization for emulsion destruction in the field oil treatment system
5	Efficiency analysis of the introduction of new technological means in the field oil collection and treatment system
6	Efficiency analysis of methods for corrosion monitoring and preventing at collection systems in the field conditions
7	Development of measures to improve the technology of field oil treatment
8	Improvement of the technology for deep dehydration of oil in the field
9	Optimization of conditions for the utilization of products in new sections and sites
10	Rationale for the choice of reagents and technology for the field oil- gas treatment

In 2015-2016, the range of retraining and advanced training programs for specialists and scientific and teaching staff was enlarged in the priority areas of the development of science and technologies in the fuel and energy sector up to 72 hours under advanced training programs and up to 500 hours under the professional retraining programs (table 6).

TABLE 6: RETRAINING AND ADVANCED TRAINING PROGRAMS FOR SPECIALISTS AND SCIENTIFIC AND TEACHING STAFF

Program length in hours	*Retraining and advanced training programs*
Advanced training programs (for 72 hours)	1. Development of hydrocarbon resources of the continental shelf 2. Increase in the motor transport operation efficiency in the conditions of the West Siberian oil and gas complex 3. Progressive methods for repair of main field pipelines 4. Peculiarities of using transport-technological machines in cold climatic conditions 5. Fire safety of oil and gas enterprises 6. Ensuring environmental safety at oil and gas enterprises
Professional retraining programs (for 500hours)	1. Development of offshore oil and gas fields 2. Ensuring safety in the design of oil and gas facilities 3. Procurement management at oil and gas industry enterprises

Within the framework of the faculty members' advanced training, which ensures the study of modern technologies of scientific and educational work, and the study of modern pedagogical technologies, the following scientific and methodological seminars were held (table 7):

The study of foreign experience in the formation of space initiated by voluntary exploratory and research activities and the creation of the necessary conditions for studying the issues of the scientific creativity methodology, including the curricula for studying the basics of psychology and creative technology, dictated the need for teachers to familiarize themselves with the theoretical and methodological foundations, the practice of organizing and ensuring the functioning of the students' research activities system.

The peculiarity of the developed technological approaches to the teaching staff qualification improvement in the process of organizing and functioning of the students' research activities was a continuous step-by-step study of the foundations of scientific creativity and scientific research in the following areas:

1. Methodological, psychological and pedagogical foundations of scientific creativity.
2. Methods and procedures for working with scientific information arrays.
3. Scientific creativity technologies.

To implement creatively a high professional potential, the aspect of research work in the system of improvement of teachers' professional skills was considered in this paper not only in terms of studying theoretical and methodological foundations and the practice of organizing students' R&D in the system of higher vocational education, but also by involving teachers to conduct pedagogical and methodical micro-surveys resulting in:

TABLE 7: SUBJECT MATTER OF THE SEMINARS

No.	*Theme*	*Seminar objective*	*Seminar tasks*
1.	Practice-oriented training at the university on the basis of modular training	Studying of technological approaches to the implementation of the practice-oriented approach at the technical university	To study the network forms of implementation of the basic educational programs; basic requirements for the development of production modules; the role of online courses in the network technology implementation
2.	Psychological and pedagogical complex for the improvement of general competencies in vocational training of oil and gas specialists to work in the new conditions of the Arctic development.	Studying of theoretical and organizational approaches to the formation of auto-psychological competence in the vocational training of oil and gas specialists to work in the new conditions of the Arctic development.	To study the general competences in the vocational training of oil and gas specialists; theoretical approaches to the formation of auto-psychological competence in the vocational training of oil and gas specialists to work in the new conditions of the Arctic development; links and relations between the components of the psychological and pedagogical complex for the development of the specialists' general competencies, taking into account the specifics of work in the conditions of the Far North and the Arctic; organizational approaches to the formation of auto-psychological competence in the vocational training of oil and gas specialists to work in the new conditions of the Arctic development.

- the new curriculum content;
- professionally-oriented special courses;
- guidance papers;
- description of new author's approaches to the solution of a certain learning problem, description of the used teaching technology;
- development of teaching aids.

CONCLUSION

The experimental evaluation of the research results concerning the enhancement of scientific research activities of students of technical universities confirms the correctness of the suggested hypothesis, the validity of its conceptual provisions and allows the authors to draw the following conclusions:

1. A high level of science-intensive professional activity of a middle technical specialist dictates the need to form a scientifically-oriented educational environment at the university which activates research activities and favors the formation of a new generation of research specialists who are ready to work in an innovative prognostic regime. The systemic , rather than one-line, one-dimensional, educational and research work is one of the most important directions in the formation of a scientifically oriented educational environment at the university, the implementation of which in the teaching and upbringing process is one of the main conditions for improving research activities at the university.
2. The didactic system developed in the targeted, contensive, procedural and organizational aspects to improve the technical students' research activities makes it possible to transform scientific knowledge into academic and to adapt the vocational training of middle-level technicians to the current requirements of science-intensive industries.
3. An indicative basis of technological support for the system of enhancing the students' research activities has been determined which includes a choice of methods and teaching aids, as well as ways of transforming the main directions of contensive synthesis in the students' research activities integrated in the learning process into the students' research activities supplementing the training process.
4. The developed information and didactic basis for mastering the theoretical and methodological foundations of scientific creativity, the means and methods of performing scientific research work by students, teaching staff and administrative and management personnel of the university enables to realize the main directions of educational, scientific and industrial integration in the students' research activities, integrated in the learning

process (scientific research elements at the lectures, hands-on seminars, laboratory practicals, on-the-job training, course and graduation project development), to consider inter-scientific problems of an industrial nature in the students' research activities complementing the educational process (a system of special courses on a single problem, occupation weeks and subject science weeks).

References

Aguado, N. (2009). Teaching research methods: Learning by doing. *Journal of Public Affairs Education*, 15 (2), 251- 260.

Ambrose, S. A., Bridges, M.W., DiPietro, M., Lovett, M.C., & Norman, M.K. (2010). *How Learning Works: 7 Research-Based Principles for Smart Teaching*. San Francisco, CA: Jossey-Bass.

Brew, A. (2003). Teaching and Research: New Relationships and Their Implications for Inquiry-Based Teaching and Learning in Higher Education. *Higher Education Research & Development*, 22, 3–18.

Byerly, A., Chang, M.J., Chopp, R., Fix, S., Jaquette, J.S. et al. (2007). *Student Learning and Faculty Research: Connecting Teaching and Scholarship*. A Teagle Foundation White Paper. American Council of Learned Societies. https://www.acls.org/uploadedFiles/Publications/Programs/ACLS-Teagle_Teacher_Scholar_White_Paper.pdf

Byung-Ro L. (2001). *Guidelines for designing inquiry-based learning on the Web: Online professional development of educators*. Indiana University.

Carini, R. M., Kuh, G. D., and Klein, S. P. (2006). Student engagement and student learning: Testing the linkages. *Research in Higher Education*, 47(1), 1–32.

Cerbin, W. and Kopp, B. (2006). Lesson Study as a Model for Building Pedagogical Knowledge and Improving Teaching. *International Journal of Teaching and Learning in Higher Education*, 18, No. 250–257.

Csermely P., Korlevic K., Sulyok K. (2007). *Science Education: Models and Networking of Student Research Training Under 21*. IOS Press.

Denham, B. (1997). Teaching research methods to undergraduates. *Journalism & Mass Communication Educator*, 51(4), 54-62.

European University Viadrina. Center for key competences and research-oriented learning. ttps://www.europa-uni.de/en/struktur/zsfl/Hintergrundinformation/Forschendes-Lernen/index.html

Fermilab Leadership Institute Integrating Internet, Instruction and Curriculum. Teacher Resource Center: LInC Projects. Available: *https://ed.fnal.gov/trc_new/projects/project_list.shtml*

Frank, E. and Opitz, C. (2002). Sovershenstvovaniye vysshego obrazovaniya v Germanii [Improvement of higher education in Germany] *Sociology of Education*, 1, 56- 60. [In Russian].

Georgieva, T.S. 1988. Puti razvitiya sotrudnichestva vuzov s proizvodstvom (iz opyta vysshey shkoly SSHA) [Ways to develop cooperation of higher education institutions with production (from the experience of the US higher school)]. *Bulletin of the Higher School.* 4, 34-38. [In Russian].

Hart L.C., Alston A.S., Murata A. (2011). *Lesson Study Research and Practice in Mathematics Education: Learning Together*. Springer Science & Business Media, http://www.en.uni-muenchen.de/students/degree/research_orient_teaching/index.html

Hu, S., Kuh, G.D., & Gayles, J.G. (2007). Undergraduate research experiences: Are students at research universities advantaged? *Innovative Higher Education*. DOI: 10.1007/s10755-007-9043-y. Available: http://www.springerlink.com/content/q330m1335k27x7k6/fulltext.pdf

Keengwe, J. (2014). *Promoting Active Learning through the Integration of Mobile and Ubiquitous Technologies.* IGI Global.

Longmore, M., Dunn, D., & Jarboe, G. (1996). Learning by doing: Group projects in research methods classes. *Teaching Sociology,* 24(1), 84-91. Retrieved from Education Research Complete database.

McClinton, J., Melton, M.A., Jackson, C.R., Engerman K.(Eds.) (2015). Infusing Undergraduate Research into Historically Black Colleges and Universities Curricula. *Diversity in Higher Education*, 17. Emerald Group Publishing. DOI: 10.1108/S1479-364420150000017014

Medical Research Programs. http://blog.prepscholar.com/medical-programs-for-high-school-students

New Jersey Institute of Technology (NJIT). *http://www5.njit.edu/research/forstudents/*

Nnadozie, E., Ishiyama, J., and Chon, J. (2001). Undergraduate research internships and graduate school success. *Journal of College Student Development,* 42, 145– 156.

Prince M., Felder R., Brent R. (2007). Does Faculty Research Improve Undergraduate Teaching? An Analysis of Existing and Potential Synergies. *Journal of Engineering Education.* October, 96(4), 283-294. *http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Teaching-Research(JEE).pdf*

Prince, M.J., and Felder, R.M. (2006). Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases, *Journal of Engineering Education,* 95, pp. 123–137, http://www.ncsu.edu/ felder-public/Papers/InductiveTeaching.pdf.

Ramsden, P. (2003) *Learning to teach in higher education*. London: Routledge Falmer.

Strangman L., Knowles E. (2012). Improving the Development of Student's Research Questions and Hypotheses in an Introductory Business Research Methods Course. *International Journal for the Scholarship of Teaching and Learning*, 6(2). *http://digitalcommons.georgiasouthern.edu/cgi/viewcontent.cgi?article=1355&context=ij-sotl.*

Student Programs. Rutgers School of Engineering. *http://soe.rutgers.edu/student-programs*

Sullenger, K.R., and Turner, R.S. (2015). *New Ground: Pushing the Boundaries of Studying Informal Learning in Science, Mathematics, and Technology*. Springer.

Tash W.R. (2006). *Evaluating Research Centers and Institutes for Success*! WT & Associates.

Teaching Teachers: Professional Development to Improve Student Achievement. *http://www.tolerance.org/article/teaching-teachers-professional-development-improve-student-a*

Umbach P.D., and Kuh G.D., (2006), Student Experiences with Diversity at Liberal Arts Colleges: Another Claim for Distinctiveness, *The Journal of Higher Education.* 77 (1), 169-192

Van Gelder, T. (2001). How to improve critical thinking using educational technology. *Proceedings of ASCILTE*, pp. 539-548. Available: *http://www.ascilite.org.au/conferences/melbourne01/pdf/papers/vangeldert.pdf*

Willingham, D. (2009). *Why Don't Students Like School? A Cognitive Scientist Answers Questions about How the Mind Works and What it Means for the Classroom.* San Francisco, CA: Jossey-Bass.

Yurko, N. 2000. Shotlandiya: drevniy klan, imya kotoromu – molodost'.[Scotland: an ancient clan whose name is youth]. *Elite Education,* 12, 42-44. [In Russian].