

MODELING OF PETROLEUM ENGINEERS DESIGN-TECHNOLOGICAL COMPETENCE FORMING IN PHYSICAL-MATHEMATICAL DISCIPLINES STUDYING PROCESS

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ABSTRACT

The essence and contents of students' project technical competence as a synthesis of design and technical competencies, including special knowledge, abilities, skills and personal qualities which are necessary for their future professional duties effective implementation, particular, for engineering projects successful implementation, requiring technical calculations performing and abilities, allowing to operate in professional activity effectively, to be guided in work situations correctly, to adapt to changing industry and the necessary conditions are revealed in the article. The main blocks of design technological competences' formation model of future petroleum engineers in the process of mathematics and the natural cycle disciplines' teaching are presented: The theoretical-methodological, functional-target, technological, methodical and criterion-evaluative, the whole combination of which is aimed at students' advanced entering in their future profession as petroleum engineers and emotional attachment to the results of their professional activity.

Keywords: Modeling, Design and Technical Competence, Student, Petroleum Engineer, Technical University, Math and Physics

1. INTRODUCTION

The oil industry has special strategic important influence as on economic development of the country so on Russian society in the whole. In recent years, it is under transitional conditions to a new technological level on the basis of innovative partnership formation of state, business, Russian science and education (Mukhametzyanova and Shaydullina, 2011). In the era of global changes in the Russian society, higher vocational education is becoming one of the large scaled and most important areas of the professional education system in

this country (Helfman *et al.*, 2009). In this regard, oil and gas industry engineers' training, particularly ways of its effective development are becoming the most important tasks of modern educational state policy.

Transition of the petroleum industry to a qualitatively new technological level needs petroleum-engineers with formed cultural and professional competencies, which are indicated in the Federal state educational standards of higher professional education by «Oil and gas business» bachelors' training direction, providing their active participation in the development and implementation of science-intensive technologies for the effectiveness of

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this transition. A great deal of the petroleum engineers' training to their future professional activities' implementation is the result of mathematics and the natural disciplines' cycle studying, which includes mathematics and physics, in the process of studying of which they possess a holistic system of professional competences, professional knowledge and skills in the occupation field, the ability to apply physical and mathematical knowledge, design methods for solving professional tasks, as their professional activities as petroleum engineers are connected with the development and implementation of projects, small groups works' designing, implementation of project tasks involving the technical knowledge (Zaripova, 2011).

The future petroleum engineer forming in the educational process occurs in the interaction of internal-professional and professional development (needs, motives, goals, tasks) and external learning. The task of the teacher is to create the adequate educational conditions and to apply adequate pedagogical technologies to help the students in understanding and realizing the necessity of self-perfection, to form the professional and personal qualities that are necessary in their future professional activities, i.e., to train competent and competitive specialists on the labor market (Kozhuharova and Branenkova, 2010). This requires possibilities' and conditions' theoretical justification of future specialists' professionally significant qualities at different stages of training in various disciplines' learning process during the training in higher educational universities.

All this allows us to conclude that the most important component of petroleum engineers' professional competence is a synthesis of design and technical competence, that is, design-technical competence, including special knowledge, skills and personal qualities necessary for the specialists' effective fulfillment of their professional duties, particularly, for the successful implementation of engineering projects, requiring the fulfillment of technical calculations, abilities, allowing to operate in professional activity effectively, to be guided in work situations successfully, to adapt to changing manufacturing conditions in various work groups. The term «project-technical competence» in psychological and pedagogical researches is defined ambiguously (Miller, 2008; Ageeva and Cotov, 2006; Boldyirev, 2013). In this regard, the urgent need appears to develop future petroleum engineers' methodical training regulation in the process of mathematical and natural-science cycle disciplines, particularly, of physics and mathematics disciplines' study, which differs from the

traditional approaches in assessing personal development of a petroleum engineer and his willingness to do his job. The research problem is defined-methods and techniques search of students-future petroleum engineers' design-technological competence formation in the process of mathematical and natural-science cycle disciplines' teaching in high school (on the example of mathematics and physics study).

2. MATERIALS AND METHODS

Petroleum engineers' design and technical competence is defined as a complex integrated system of specialists' professional competences, reflecting the synthesis of technical and engineering knowledge, abilities, skills, intellectual abilities, the value orientations' aggregation, action programs, motivations and needs in professional self-improvement, which are manifested in professional activity of a petroleum engineer, linked to technical and technological projects' design and prediction.

In connection with the submitted definition the purpose of petroleum engineers' design-technological competence formation in the process of mathematical and natural-science cycle disciplines' studying is these disciplines' necessary capacities' accumulation, which will be updated in process of professional activities' realization and which are connected with project activities and technical calculations. As the objectives of the research the following ones were defined: The development of cognitive interests' and students' educational motivation to study mathematics and physics; integration of students' educational and research activities; the forming of students' skills in designing activity; an advanced entry into the future professional activity; development of reflective and evaluative activities' skills.

Functions of design-technological competences' forming of the future petroleum engineers in the process of mathematical and natural science disciplines' learning are the following:

- Developmental function-in accordance with the educational objectives aims to raise the future specialists' general development level are defined, creativity, critical thinking, ability to analyze, ability to find the right solution are formed, educational activity is initiated, the willingness to overcome difficulties, to identify and eliminate their causes are formed
- Raising function-in students' design-technological competences' forming process their sense of

responsibility, collectivism, basics of self-awareness, self-esteem, assertiveness in training activity, independence, commitment to the achievement of the target are formed

- The classification function-on the basis of a differentiated approach, students are divided into subgroups by training level during their training at University, which helps to intensify the process of students' education and self-education, select their individual study plans, as well as the selection of perspective students with regard to their potential and their further targeted training that takes into account the modern labor market requirements
- Vocational orientation function-conscious awareness of continuous education and self-development's need for a successful professional activity (Gafurova, 2013); design and technical competence level's evaluation in students' development as the quality of their professional training can serve as the basis for different groups of students' allocation with recommendations for future employment, for the type of their future professional activity or continuation of their studies
- Advancing innovation function-students' ability to design their professional activities, their readiness to connect a career with continuing education (Karpov, 2004), commitment to innovative entrepreneurship

3. RESULTS AND DISCUSSION

The future petroleum engineers' design-technological competences' forming model in mathematics and physics studying process, consists of elements which are in an interdependent relationships and connections with each other and form a certain integrity, unity, which allows to distinguish the following structural units:

The theoretical part reflects the main regulations of future engineers' design-technological competences' necessity formation (social and state order; the requirements of technology, education and innovative production development's modern stage; state standards of the third generation; the model of the modern oil industry engineer) and includes a dialectical relationship of modular competency-based, integrative and project-oriented approaches, the implementation of which is aimed at the efficient development of design and technical competences of future petroleum engineers in learning mathematics and physics; justification of principles' set: Consistency, integration, professional orientation, modularity, problem, innovativeness (Zaripova, 2014a).

The functional target part of the model is the basic one. It reflects the main purpose of design-technological competence's forming of future petroleum engineers in mathematics and physics teaching process, which includes private, psychological, pedagogical, methodological and social objectives. Psychological-pedagogical goals mean students' self-organization, self-evaluation, reflection skills, formed on the basis of oil and gas profile modern specialists' competence model, suiting to innovative manufacture, society and competitive personality requirements (Seddigi *et al.*, 2009; Hesson and Shad, 2007). Technique goals of this component of students' design-technological competence model's formation in physics-mathematical disciplines' learning are focused on the complex technologies, methods of organization of students' educational and designing activities' using and the most optimal choosing of them to ensure the most efficient development of professionally important qualities of future petroleum engineers. The social objective consists of special conditions' creating for students' professional competences' forming, providing their fast adaptation to future profession, forming of creativeness, capacities and needs for self-education, professional competences' level increase, readiness to change professional activity and innovative entrepreneurship.

The content block of the a model is a reflection of its priority goals and tasks, which represents a set of fundamental and special knowledge, determination of general professional disciplines' list with the aim of inter-subject links' establishment with them; defining the system of project and technical knowledge and skills with design and technical tasks' and students' project tasks' further selection and development for their independent work; interrelated organization of theoretical and practical activities, students and teachers educational-research and project-oriented activities' organization, cognitive and project activities results' forecasting.

The basics of a model's content block are the federal state educational standards of high professional education, mathematics and physics disciplines' curricular and plans. The content block includes physics-mathematics disciplines' content selection and structuring and its integration with students' educational research and design activities, during the work with which they master the methods of analysis, synthesis, generalizing, classification, methods of work with information.

The basic units of physics-mathematics disciplines education's content with the aim of design-technological competence's forming among students

are occupation oriented physical-mathematical problems and design tasks, which can be solved with the use of mathematics and physics apparatus and require technical and engineering knowledge, skills and competences for the implementation of their future professional activity. In the process of professionally-oriented goals and project tasks' solving the assimilation of mathematics and physics at the level of the individual senses is carried out, which builds up the project and technical component of future petroleum engineers' general professional competence.

Technological block of future petroleum engineers' design-technological competences' model forming in the process of mathematics and physics studying consists of teaching methods' development, optimal choice of teaching technologies, methods and techniques (the method of projects, portfolios of personal achievements, Internet-technologies, technologies of finding, processing and analysis of information, referencing, problem situations' analysis method and others), mechanisms of students' educational and research and project activities with professional orientation of physics-mathematical training in a technical University.

Methodological block of model is an educational-methodical support of students' design and technical competence's development in their mathematics and physics studying, which includes curricula, methodical guides for students, methodological guides for teachers, diagnostic tests and methodical recommendations on the students' training and designing activities organization in these disciplines' studying process. Methodological part of the proposed model is directed on these disciplines teachers' extensive training for their productive cooperation, not only with students, which is based on a system of their future professional activities' training, on future petroleum engineers' general and professional competences' forming, but also for teachers' meaningful dialogue with their colleagues as of general professional so of special disciplines and as well as with representatives of the professional community for timely adjustment, achievements' rational ways finding and content's updating of mathematics and physics' teaching technologies, aimed at future petroleum engineers' design-technological competences' forming (Zaripova, 2014b).

Criterion-referenced strategy evaluation block contains a set of criteria and indicators of students' design and technical competence's development level and allows to judge about the application's efficiency of the considered components in its forming process. Criteria of design-technological competences' forming

are: Motivational criterion (the awareness of the necessity of design-technological competence's forming, students' motivation to study mathematics and physics as a means of their design and technical competence' forming) (Shichkov, 2013), cognitive criteria (mastering of physics and mathematics knowledge and skills' system), operational criteria (developed skills for independent transferring of obtained knowledge into professionally-oriented physical-mathematical tasks and engineering tasks' solution), reflexive criterion (the ability to introspect, to do objective self-assessment, self-criticism). The proposed criteria indicators of future petroleum engineers' design-technological competences' forming in physical-mathematical disciplines' studying process are: Persistence, educational activity and independence; confidence in goals' achievement in professional activity; good amount of knowledge on the subjects; academic performance and progress; the effectiveness and efficiency of knowledge application in new situations; updating of knowledge for professionally-oriented tasks' solution and project tasks' performance; readiness to self-organization, adequate self-esteem; intention to self-improvement, self-realization; awareness of the need of continuous educating and learning; prerequisites to innovative entrepreneurship's implementation.

At this stage also reasons hindering the students' design-technological competence's forming in mathematics and physics' studying are revealed and their prevention ways are presented. After that promising directions for pedagogical and methodological conditions' study for students' design-technological competence's forming at technical University are developed.

4. CONCLUSION

Thus, the developed model of future petroleum engineers' design-technological competence's forming in physical-mathematical disciplines' studying process reflects the essence of this process, which consists of physics - mathematics and special knowledge, skills and ways of activities' acquisition, enabling the students to solve the technical problems, to see and solve the problems arising in their future industrial practice, to carry out design tasks, which helps to contribute to their intellectual potential in the future professional activity. The proposed model's implementation conditions are the following: Education and industry spheres' integration; the advanced nature of the disciplines' content; training and scientific research activities' integration; the disciplines' content orientation on the future petroleum

engineers' training for innovative entrepreneurship; technical universities students' training and self-preparation intensification; the selection of promising students taking into account their potential and their further addressed training for modern labor market.

5. RECOMMENDATION

Further research requires: To develop an algorithm of students design-technological competence model forming implementation in the process of physics and mathematics studying, to identify the possibilities of its implementation in other disciplines study; to justify the role of students educational and research activity integration during the whole period of education in university, innovation and entrepreneurial activity of university, implying participation of all participants of educational process and representatives of the business sector in the development and promotion of innovative technical and technological projects on the labor market, as main conditions of future petroleum engineers design and technical competence effective forming.

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