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Review Article

FORMATION OF MATHEMATICAL COMPETENCE AS AN ESSENTIAL ELEMENT PROFESSIONAL TRAINING OF FUTURE ENGINEERS (ON THE EXAMPLE OF SURGUT BRANCH OF TYUMEN INDUSTRIAL UNIVERSITY)

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Abstract

The article reveals the essence and structure of the formation of mathematical competence and shows the importance and relevance of the mathematical competence of engineers in oil and gas business by analyzing and systematizing the literature used, and also develops and proposes a method of forming mathematical competence in using the project method. The author defines the mathematical competence of future engineers as: readiness to apply mathematical knowledge in solving actual professional problems; experience in applying mathematical knowledge in professional activities; confidence in their capabilities to successfully use mathematical methods in solving scientific problems in future professional activities; desire and willingness to learn new things that go beyond the usual activities.

Keywords: mathematical competence, future engineers, training, structure, model.

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INTRODUCTION

Of particular importance in the Russian economy are oil and gas companies, which constitute the main production and economic potential and are in great need of qualified personnel who are able to carry out professional activities in the conditions of technical and technological modernization. A competent specialist in the highly intelligent oil and gas industry should integrate knowledge and skills with the ability to apply the knowledge and skills to solve problems that arise in production practice when solving problems of modernizing production facilities, efficient use of fields, reducing accident rate, cleaning technology, etc. [2].

Mathematical education is one of the basic elements of the vocational training system for future engineers of the oil and gas industry at a university. For students of engineering specialties, mathematics is not only an academic discipline, but also a tool for analyzing professional activity, organization, and process control.

The relevance of this topic lies in the problem of training a highly qualified specialist with modern professional competencies [4].

The purpose of the study was to develop and implement mathematical training, ensuring the formation of professional mathematical competence of oil and gas engineers on the example of the TIU branch in Surgut.

The objectives of our study are:

1. To reveal the essence and structure of the formation of the mathematical competence of engineers in the oil and gas business.
2. Show the importance and relevance of the mathematical competence of engineers in the oil and gas business.
3. Develop and propose a model for the formation of the mathematical competence of oil engineers.

THE CONCEPT OF MATHEMATICAL COMPETENCE

Mathematical apparatus and its underlying mathematical methods are increasingly penetrating all human activities. Knowledge of mathematical methods is no longer just a means of overall development and skills of elementary calculations. Mathematical mindset becomes necessary for specialists in all areas of scientific and practical activities.

One of the components of professional competence of future specialist is mathematical competence, which scientists examined L.V. Vasyak, V.V. Poladova, S.A. Tatyanenko, M.A. Khudyakov, L.K. Ilyashenko [2, 3, 6, 14-16]. Mathematical competence of future technical college graduate researchers define differently.

There are different points of view in determining the mathematical competence. Some scientists, such as V.P. Matveykin, in determining the mathematical competence, in fact, describes the result of mathematical training, which is aimed at the formation of the ability to see, realize and evaluate various problems constructively to resolve them in accordance with their values, consider any difficulty as a stimulus for further development [12]. Others argue that the mathematical competence is an integrative personal quality, based on a set of fundamental mathematical knowledge, practical skills, shows the willingness and ability of the student to carry out professional activities. Still others, such as D.D. Gelfanova,

A study of psychological and pedagogical literature, we found that in the domestic theory and practice there is no single view of the definition of "mathematical competence", there is no single research approach to the composition of the structural components of mathematical competence are not defined methods and factors that contribute to the formation of mathematical competence of specialists in high school.

Mathematical competence, on the opinion of A.M. Aharonov and O.V. Znamenskoye is presented as an integral property of the person, which is expressed in the presence of deep and strong knowledge of mathematics, the ability to apply existing knowledge to new situations, the ability to achieve significant results and quality in the work [2]. In other words, mathematical competence presupposes a high level of knowledge and experience of independent activity on the basis of this knowledge.

According to V.G. Plakhova, mathematical competence of students of technical colleges – the ability of students to enable them to apply the system of acquired mathematical knowledge and skills in the study of mathematical models of professional applications, including the ability to think logically, to evaluate, select and use information to make decisions.

According to L.K. Ilyashenko, mathematical competence of the future engineer in the oil and gas business is seen as a unity of epistemological, praxeological, axiological component, providing him the ability to solve theoretical and practical engineering problems relevant in professional work of the modern professional engineering and technical profile [6].

After analyzing the information on the mathematical competence, we came to the conclusion that this expertise

contributes to the adequate application of mathematics to solve problems in everyday life. The value of mathematics is that it contains large-sized pieces of information that a reasonable person to develop more reasonable – in individual thinking person with the individual characteristics of behavior [2].

According to the academician L.D. Kudryavtseva, the overall objective content of mathematical courses should be university graduates in acquiring certain mathematical training, the ability to use the study of mathematical methods in the development of mathematical intuition, in the education of mathematical culture. Experts (university graduates) have to know the basics of mathematical tools necessary for solving theoretical and practical problems that have a fairly high level of development of logical thinking, to be able to translate a practical problem with professional language into mathematical language. Mathematics education will most effectively contribute to the formation of future engineers of a certain system of professionally significant qualities if its scope and content will be adequate future operations,

We believe that mathematical training at the technical university should be addressed to the channel formation of mathematical competence of students.

Formation of professional competence of students in recent years engaged in the Russian scientists, such as E.V. Bondarevskaya, A.I. Winter, A.V. Farmstead. The results of their research in the implementation of competent approach shows a significant increase in the quality of professional training of future specialists.

The professional competence of the future engineer to a great extent depends on the quality of mathematical training, which is the basis of mathematical competence [1].

Strengthening the mathematical training of future engineers determines the success and effectiveness of their activities, not only in manufacturing but also in scientific activity. Knowledge of mathematical methods and mathematical mindset becomes necessary for specialists of engineering directions of scientific and practical activities. The study of higher mathematics course forms students both the theoretical basis for mastering general professional and special disciplines and practical skills to enable future engineers to find rational solutions applied direction of problem tasks.

According to R.I. Ostapenko, mathematical competence of students of technical colleges - the ability of students to enable them to apply the system of acquired mathematical knowledge and skills in the study of mathematical models of professional applications, including the ability to think logically, to evaluate, select and use information to make decisions [13].

PROBLEMS OF TEACHING MATHEMATICS IN A TECHNICAL UNIVERSITY

Obviously, the problem of teaching mathematical competence is the lack of guidelines, allowing to form a mathematical competence and not the estate of objective diagnostic educational activities. Also a problem is the weak mathematical preparation of students who came to study after upper secondary education. Lack of motivation and desire of students to receive quality knowledge, develop mental abilities and build mathematical competence.

Problems of teaching mathematics in the Russian high schools are associated with reducing the number of hours devoted to mathematics; increased time on self-study material; the gap between the level of mathematical knowledge of high school graduates and university requirements; the growing gap between the level of mathematical knowledge of graduates and the objective requirements of modern science and technology.

Problems of teaching mathematics at foreign universities are associated with a variety of formulas and drawings, educational and research tasks that requires complex calculations, including the use of computer programs, the lack of interdisciplinary connections. The causes difficulties for exchange students are the existing language barriers and differences in educational systems and the educational process.

MATHEMATICAL COMPETENCE FORMATION MODEL

Mathematical knowledge in professional activity focused on the following objectives: the formation of students sufficiently deep fundamental knowledge; training in the application of mathematical knowledge in the future engineering activities; shaping, allowing to make and investigate mathematical models; forming conscious trainees subject competences [10].

Formation of mathematical competence depends on the carrying out of mathematical lectures, webinars and workshops, use of project - individual and group [8]. Basis for the formation of mathematical competence is project-based learning for students in the field of architecture, construction and engineering, as well as a specially designed package of multi-level system of mathematical and professionally oriented tasks to diagnose and develop competence. Consideration should be given to the use of techniques of creative engineering talent and creativity and inventive problem solving.

Technological model of formation of competence in mathematics consists of elements whose interdependent relationship and communication with each other to form a certain unity, a unity that allows us to distinguish the following structural units: the theoretical part reflects the main points of design and technological competence of the future engineers whose formation is necessary and has a social and public the order; requirements for technology, education and innovation of the current stage of development of production; the state of the third generation of standards; model of modern petroleum industry and switch module-dialectic ratio competency, and integrative approaches -oriented design, implementation of which is aimed at the development of effective design and technical competence. Future petroleum engineers in the process of studying mathematics and physics justify a set of principles: consistency, integration, professional orientation, modularity, the problem of innovation. The functional target of the model is the base. It reflects the main goal: the formation of engineered and technological competence of the future of Petroleum Engineers in the process of learning mathematics, which includes private, psychological, pedagogical, methodological and social challenges [7].

Block the content model is a reflection of its priority goals and objectives, which are fundamental and specialized knowledge, specific list of general professional disciplines in order to establish interdisciplinary connections with them; definition of systems engineering and technical knowledge and skills.

The main unit of the model are the federal state educational standards of higher education in mathematics curriculum and lesson plans [7].

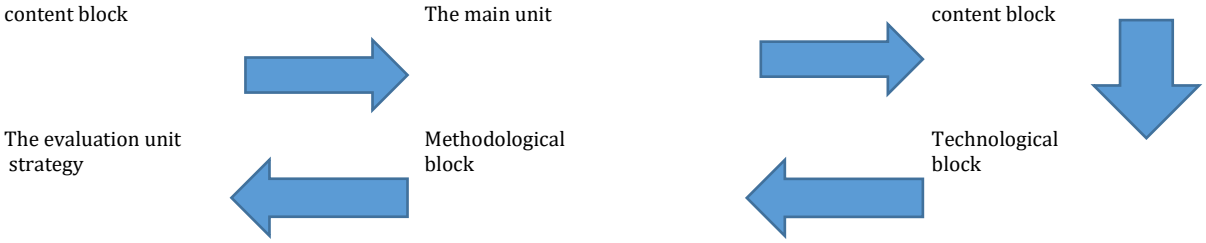
Content unit includes a physical-mathematical disciplines selection and structuring of the contents, and its integration with academic research and engineering students activity during which they learn the methods of analysis, synthesis, synthesis, classification methods work with information.

Technological block future of Petroleum Engineers: building model design and technological competencies vprotsesse study mathematics and physics is to develop teaching methods, the optimal choice of technology, methods and techniques of learning mechanisms of teaching and research and design activities with vocational guidance of physical and mathematical training at the Technical University.

Methodological block model – it is a teaching software engineering and technical training of students, the development of competence in mathematics, which includes training programs, teaching aids for students, teaching aids for teachers, diagnostic tests, and guidelines for the organization of training and project activities of students in the study of these disciplines.

Block evaluation strategy, based on the criteria includes a set of criteria and indicators of students' level of development of design and technical competence and gives an indication of the effectiveness of the components in the process of its formation. The criteria for the formation of the design-technological competences are motivational criteria, cognitive criteria, operational criterion reflective criterion. The proposed criteria are indicators buduscheyproektno-technological competence of Petroleum Engineers, the formation processes in the study of physical and mathematical sciences: perseverance, educational activities and independence; confidence in achieving objectives in their professional activities; a good amount of knowledge on the subject; academic performance; efficiency and effectiveness of the use of knowledge; readiness for self-organization, self-esteem; intention to self-improvement, self-realization; awareness of the need for continuous education and training; prerequisites for the implementation of business innovation.

Technological model of competence



Mathematical competence consists of the following components:

1. The general scientific mathematical competence (OMC).

2. Applied Mathematical competence (PMK).

The analysis of general cultural competences educational standard graduate must have the following general scientific mathematical competence (OMC):

graduate must demonstrate:

OMC-1 – possession of mathematical culture of thinking, the ability to synthesize, analyze, the perception of information, setting goals and choosing the ways to achieve it;

OMC-2 – the ability to logically true and clear arguments to build mathematical oral and written language;

OMC-3 – a willingness to cooperate with colleagues, work in a team;

OMK-4 – the ability to independently acquire and use in the practice of mathematical knowledge and skills, the desire for self-development [2].

An analysis of the professional competences of the graduate should possess the following competencies in applied mathematics (PMK):

graduate must demonstrate:

PMK-1 – the ability to use the basic laws of mathematical disciplines in professional work, to integrate knowledge from different sections of the mathematics;

PMC-2 – the ability to apply analytical, computational methods for solving applied problems in the field of technology.

PMK -3 – the ability to make science-based decisions on the basis of mathematics, to carry out setting and perform experiments to verify their correctness and efficiency;

PMK-4 – the main provisions of the laws and methods of mathematics; ability to identify natural-science nature of the problem arising in the course of professional activity, readiness to bring solutions to their corresponding mathematical apparatus;

PMK-5 – the ability to develop and apply mathematical model corresponding to the process in the course of professional activities.

According to the Federal State Educational Standard mathematical competence are formed in the course of the study the following sections of mathematics: Linear algebra; Analytical geometry in the plane; Analytical geometry in the space; Concepts mathematical analysis; Differential calculus of functions of one variable; Functions of several variables. Discrete Math; The indefinite integral; The definite integral; Double and triple integrals; The line integral; The surface integral; Elements of Algebra; Differential Equations; Theory of series; Probability Theory and Mathematical Statistics [8].

DEVELOPMENT OF A METHOD FOR FORMING MATHEMATICAL COMPETENCE USING THE PROJECT METHOD

The content of the data subject areas of mathematics is structured on the basis of the federal state educational standards so that its implementation in the learning process of students contributed to the formation of mathematical competence identified.

Except compulsory study subject areas of mathematics offer to introduce an additional method of forming mathematical competence using a method of projects [9].

The method is as follows:

1. It is necessary to conduct a webinar or workshop on a specific topic;
2. Create and distribute to groups of students ranks of multi-level system of mathematical and professionally oriented tasks;
3. To analyze the solutions of the problems;
4. Develop and implement a scientific and practical activities with the involvement of students to work on a project that comprises the following steps:

Organizational-preparation (forming groups of students)

Planning (preparation of the work plan)

The process (work in groups to create a project)

The final (presentation of results, presentation, discussion)

To create and organize the projects we have developed the direction of the project activities of students in mathematics.

1. Mathematics around a petroleum engineer. In doing so, students can carry out projects on the themes: "a petroleum engineer and mathematics"; "Probability theory in the oil and gas industry"; "Using a petroleum engineer mental arithmetic"; "The study of trigonometry in technical universities"; "Numerical methods and optimization techniques for petroleum engineer"; "Elementary algebra as a basis for engineering profession"; "Analytical Geometry Oil Industry"; "Statistics in the oil and gas industry"; "Mathematics and Geology".
2. Mathematical Laboratory – direction, is focused on creating a list of materials and equipment for practical work in mathematics and the accumulation of measurement equipment, accounts, solve problems, etc. [11].
3. The history of the oil industry with the use of mathematics, that is, the study of ancient methods of extracting oil and gas, the implementation of projects on the topics: "The transition from manual to mechanical drilling method"; "The transition from the mechanical drilling process to automatic"; "Settlements on the development and exploitation of oil and gas wells 100 years ago"; "The use of mathematics geology"; "The first mathematical models for the development of the field"; "As predicted, and evaluated oil and gas reserves first oil"; "The construction of the first oil and gas pipelines."
4. Create a collection of oil and gas industry problems (construction and repair of transport oil and gas pipelines, development of oil and gas fields, analyzing failures of pump equipment and storage tanks, the calculation of well flow rate, etc.).
5. Mathematical excursions production, oil and gas processing plant, history museums and the first oil and gas institutions stabilization plant condensates, compressor stations, etc.

Proposed areas of project activities allow students to delve into the study of mathematics as a discipline, as well as increase the level of understanding and visualization.

Resulting in the formation of the following mathematical competencies:

- demonstration of basic knowledge of mathematics (formulates the definition of basic concepts, reproduce basic mathematical facts, laws, principles, recognizes the mathematical objects, understand the connection between mathematical concepts and has an idea of the different mathematical structures);
- owns the domain of mathematics language can express correctly and convincingly justify the position of the subject area of mathematics (correctly uses the basic mathematical concepts, facts, symbols, shows the proof of theorems and explain their course, has knowledge of the subject area terminology);
- apply mathematical knowledge to solve problems (to apply theoretical facts in solving common tasks, owns the basic methods of solving problems is the relationship between physical and mathematical disciplines, represents the connection of mathematics with other sciences).

CONCLUSIONS

The essence of the structure and formation of mathematical expertise and shows the importance and relevance of mathematical competence engineers case on oil and gas by analysis and systematization of literature and also been developed and proposed a method of forming by the use of mathematical competence projects method.

Thus, the above considerations make it possible to determine the mathematical competence of students – future engineers as the willingness to use mathematical knowledge in solving urgent professional tasks; experience in the application of mathematical knowledge in professional activity; confidence in their ability to successfully use mathematical methods for solving scientific problems in the future professional activity; willingness to learn new things, going beyond the usual activities.

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