

Review Article

MATHEMATICAL PROBLEM AS A MEANS OF PROFESSIONAL COMPETENCE FORMATION IN TERMS OF A TECHNICAL UNIVERSITY

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Abstract

The essence of the mathematical problem as the main means of forming the competence of students of technical universities is disclosed in the article and the relevance of addressing the problem approach in the learning process is shown, and a methodology for the formation of key competencies through solving technological problems has been developed and proposed. The task approach allows you to build the ability to solve professional problems through mathematical modeling, the ability to establish relationships of mathematical knowledge with the content of courses in special disciplines.

Keywords: mathematical problem, professional competence, teaching methods, students, technical university.

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INTRODUCTION

Currently, in the midst of changes, new requirements are being presented to the training of young specialists in Russia. Society needs highly qualified, professionally competent, creatively thinking, capable of making the right decisions experts. And the formation of modern professional competence is becoming one of the main functions of the entire process of training future engineers.

It should be noted that in science the problem of competence is quite effectively developed and comprehensively considered, but at the same time, scientific disputes about the essence of competence and its relationship with competence are still ongoing; The problem of key, basic and special competencies is discussed. From the point of view of our research, the formation of professional competence among students of a technical university is of particular interest.

Professional competence is an integral characteristic of the personality of a specialist, represented by a set of competencies in the professional field of activity, including his personal attitude to her and her subject.

The formation of professional competence is facilitated by mathematical education. Mandatory requirements of mathematical education at the university are: continuity of study and the use of mathematics; fundamental mathematical training; focus on the practice of mathematics; the equivalence of mathematical training for all forms of training in the same specialty; continuity of mathematical training at all levels of education [1]. In a technical university, mathematics acts as a special educational discipline, since the knowledge gained in mathematics is the foundation for the study of other general educational, general engineering and special disciplines.

In the process of teaching mathematics, it is necessary to develop the intellectual abilities of students, focus on the formation of their productive thinking, professionally significant intellectual skills. The knowledge and skills acquired by students should become a tool for solving the problems of other disciplines in the future profession. Students should be ready for independent activity and for the application of the acquired knowledge and their improvement, for the acquisition of new knowledge. Thus, the organization of training that implements the requirements of a professional orientation involves active educational and cognitive activity of students, characterized by conscious motivated interest and independence.

Therefore, the modernization of the higher education system, which requires the search for ways to improve the quality of training of graduates in the field of "Oil and Gas Business"

through the implementation of a competency-based approach, is of particular relevance.

THE CONCEPT OF "CHALLENGE" AND THE REPRESENTATION OF IT

The process of formation of mathematical competence among future engineers determines their preparation for mathematical activity related either to the search for solutions to specific problems, or to the search for evidence of specific theorems.

The concept of "task" is one of the fundamental concepts of mathematics and the methods of teaching it. Currently, several approaches to the interpretation of this concept have been developed.

In the most general sense, a task can be interpreted as a goal that must be achieved, as a question requiring resolution on the basis of certain knowledge and logical conclusions.

In various fields of knowledge (psychology, pedagogy, mathematics, mathematics methodology), the problem of the content of the concept of "problem" was studied by many scientists: A. N. Leontyev, L. S. Rubinstein, L. M. Fridman, Yu. M. Kolyagin, G. I. Sarantsev, D. Poia, A. A. Stolyar, etc.

Proponents of the interpretation of the task as a situation in which the subject must act clearly include it in the very concept of the task. In the methodology of teaching mathematics, such an interpretation of the problem is characteristic of the works of Yu. M. Kolyagin and G. I. Sarantsev. They note that without a subject there is no problem. What is a task for some may not be for others [2].

Proponents of the following interpretation of the concept of "task" believe that the subject does not turn on. This point of view is presented in the works of L. M. Friedman, who defines the problem as a model of a problem situation, expressed using the signs of some natural and artificial language [3]. Along with the task, the concept of a problem situation is also used in the methodology of teaching mathematics and psychology. These concepts have much in common, but in most studies they are not identified. For example, L. M. Fridman considers the concept of a problem situation to be the initial one. A. M. Leontyev does not explicitly connect the problematic situation with the task, however, notes that the problem leads to the subject's awareness of the problematic situation and an indication of its resolution. L. M. Fridman notes that a problematic situation arises when a subject in his activity directed at an object encounters some kind of difficulty, an obstacle. However, the problem situation is not just a difficulty, an obstacle to the subject's activity, but a

difficulty realized by the subject, and he wants to find a way to eliminate it. Thus, L. M. Fridman, as well as G. I. Sarantsev and Yu. M. Kolyagin, includes the subject in the concept of a problem situation. This means that the task is a model of the situation, an important element of which is the subject, who realized the difficulty in his activity. Therefore, the occurrence of any task is associated with the activity of the subject [4].

According to L. M. Fridman, the differences between the concepts of "task" and "problem situation" are explained by the fact that the problem situation exists realistically, and the task is an abstract model of the real situation presented in any language, and therefore the problem situation is always richer in content than a task that reflects only some of its sides. For each problem situation, there is one or more tasks that can differ from each other both in the totality of the properties of the situation presented in them, and in the language in which they are expressed. Yu. M. Kolyagin argues that "the problem situation does not give rise to the problem by itself, but with the active participation of the subject, who sees a problem in some situation". Each task becomes a task essentially only when the subject "accepts" this task, i.e. begins to work on her solution. The task is more correctly understood not as an external situation, but as a "situation for the subject". The term "task" is especially widely used in characterizing thinking processes. In this regard, it is very common to understand the problem as a situation in which the subject, in order to achieve his goal, must find out the unknown based on the use of his connections with the known [5].

Yu. M. Kolyagin approaches the characterization of the problem using the concept of a system, defining it as something whole, abstract and real, consisting of interdependent parts: components of a system, their properties and the relationships between them. Yu. M. Kolyagin in a mathematical problem distinguishes the following components: initial state (task condition); final state (task conclusion); solution (transformation of the conditions for finding the desired one); the basis of the solution (its theoretical foundation), considering as mathematical all problems in which the transition from the initial state to the final is carried out by mathematical means. The author includes purely mathematical problems in this group, all of whose components are mathematical objects, and applied mathematical problems solved by the mathematical apparatus.

S.F. Dorofeev considers the task as a specific situation of the subject - the object category, which must be resolved taking into account the conditions specified in it [6].

We adhere to the point of view of Yu. M. Kolyagin, G.I. Sarantsev, L.M. Fridman and we mean by task a certain situation of a subject-object category, which must be resolved taking into account the conditions indicated in it. The main means of forming mathematical competence among students of technical universities are mathematical problems. By the level of complexity, it is possible to distinguish educational mathematical problems for the formation of basic knowledge, tasks for consolidating basic knowledge, tasks for the formation of fundamental knowledge and tasks for their consolidation, tasks for the formation of research skills and tasks for the development of creative thinking. Thus, the educational mathematical problem should be understood as a certain goal of mathematical activity, set before the students in the form of a training task. Performing tasks of this kind, students master not only the knowledge and skills necessary at this stage of the educational process, but also develop their personal qualities. Training tasks are performed in solving specific mathematical problems and are a synthesis of the subject problem and the educational goal. The same mathematical problem can serve the achievement of several specific educational goals and, therefore, be a component of several educational problems. At the same time, a particular educational goal can be achieved by several subject tasks [1].

Summing up, we can conclude that the idea of the problem depends on the field of knowledge that it reflects. Using this

term in one sense or another, it is necessary to indicate what content is attributed to the concept of "task".

MATHEMATICS IN A TECHNICAL UNIVERSITY: PROBLEMS

Modern mathematics in a technical university has now found itself in a difficult situation, since it is the most abstract of all sciences and, thereby, is most distant from the basic needs of man. We believe that thanks to a high degree of abstraction, mathematics is a kind of foundation for all natural sciences, that without it, no science can exist that operates with any quantitative data.

The study of mathematics gives the future engineer not only a certain amount of knowledge, but also develops in him the ability to pose, research and solve a wide variety of problems. In other words, mathematics develops thinking and lays a solid conceptual foundation for the development of many technical disciplines.

A mathematics course is one of the most difficult for students to master at a technical university. We have analyzed this problem in the TIU branch in the city of Surgut. One of the reasons for these difficulties is that mathematics is the most abstract of all sciences, it operates with objects that do not exist in nature. The second reason - too much material has to be studied in a limited allotted training time. Many first-year students do not have time to "digest" the concentrated amount of material in mathematics. The number of hours devoted to the study of mathematics every year is reduced. For example, sometimes it is necessary to abandon certain branches of mathematics, for example, sections of analytic geometry, in the name of preserving the completeness and certain coherence of the presentation of mathematical analysis and linear algebra.

Also, in each group, commercial students study, i.e. those who pay for their studies. For their frequent school preparation is extremely weak. Many of them should not have been taken to the university, since there can be no talk of any full-fledged education.

Another important problem is the lack of highly qualified teachers who are able to improvise in lectures, sensitively grasp the level of preparedness and understanding of the audience, use some special technical terms in the course of mathematics.

TECHNOLOGY OF TEACHING STUDENTS TO SOLVE MATHEMATICAL PROBLEMS

Teaching students of a technical university should be primarily practice-oriented. The technology of training students to solve mathematical problems, as well as the study of professionally oriented problems, should be carried out in stages, so that the tasks are understood and their solution is meaningful [7].

At the first stage, it is necessary to use tasks aimed at the formation of skills and abilities to solve these problems at the algorithmic level and the ability to formulate them at the operational level;

At the second stage, it is necessary to use tasks aimed at the formation of skills to solve these problems at the heuristic level and the ability to formulate them at the technological level;

At the third stage, it is necessary to use tasks focused on the formation of skills to solve applied and practical problems at a creative level and the ability to formulate them at a generalized level.

Let us dwell in more detail on the technology of forming professional competence. In relation to our study, the formation of future professional competence among students of a technical university can be described as the process of acquiring and developing components of mathematical competence, which is characterized by the ability to solve mathematical problems and technological content.

From the point of view of the formation of mathematical competence in future engineers, applied problems and tasks of a professionally oriented nature are of interest.

A professionally oriented task is a task whose condition and requirement determine a model of some real situation that arises in the professional activity of an engineer, and the study of this situation by mathematical methods determines the professional development of the student's personality [8]. For this purpose, we propose using tasks of the following type:

Line AB slides along the sides of a right angle. The point M is taken on it so that $MA = a$, $MV = b$. What line does point M describe?

We define the rectangular Cartesian coordinate system OXU so that the OX axis is aligned with OB, the Oy axis is β with the OA axis.

Let the point M have coordinates $(x; y)$. Denote by t the magnitude of the angle OVA. Then $x = a \cos t$, $y = b \sin t$, where $0 \leq t \leq \angle OAB$, whence we get that

$$x^2/a^2 + y^2/b^2 = 1$$

As you know, this equation defines an ellipse. Point M describes part of the ellipse. As a rule, in the process of this task, students rightly notice that if the point M is the middle of the segment AB, then when sliding the segment AB it describes an arc of a circle.

The methodological significance of this task lies in the fact that in the process of solving students master the methods of compiling implicit equations of functions. This task also has important methodological significance, since its result constitutes the theoretical basis for the operation of turning and milling machines, a crank mechanism, which is part of the operation of machine assemblies. The task performs an important motivational function, since it contributes to the formation of students of a technical university of interest in studying the properties of curved lines.

In the process of formation of mathematical competence among students, the possession of methods of scientific knowledge acquires great importance, among which the most important are: observation, comparison, generalization, analysis, induction and deduction, abstraction, concretization, analogy [9].

We also propose to consider and solve the problem of technological content, for example, after studying theoretical material on probability theory:

"In the oil-bearing region, 6 wells are being drilled simultaneously. Each well reveals fields independently of others with a probability of 0.1. What is the probability of opening a field? How many wells need to be drilled so that the probability of opening a field exceeds: a) 0.7; b) 0.8; c) 0.5; d) 0.9?"

Training Methodology:

The main stages of the organization of training in the scenario of the business game "Conditional probability. The probability of the occurrence of at least one event from the full group of events"

I stage. Testing and consolidating the level of knowledge of students on issues related to the content of this topic.

II stage. The choice of formulas and methods of solution. Collective discussion of problem solving in groups. (The division of participants into small creative groups (3-5 people), each group decides its own version).

III stage. Solving a problem in small groups, preparing speeches to discuss solving a problem. Monitoring the work of each participant with setting and explaining grades for individual work.

IV stage. The solution to the subproblem: to assess the influence of one of the criteria for the probability of opening a field. Discussion of results with scoring.

V stage. Summing up the game, analysis of errors, reasons for issuing incentive and penalty points. Discussion of the resulting final grades.

The formulation of problems of this type makes it possible, on the basis of existing theoretical knowledge, to find methods for their specific solution and the formation of competencies.

Another technique for building professional competence is to perform laboratory work in the form of technological tasks [10-12], use a computer program package to perform and analyze the results of computational experiments, such as: "Based on the geological data of the field, calculate oil reserves and change average reservoir pressure within the oil reservoir".

Training methodology: Stage I: to study the results of geological surveys and determine the methods of calculations; Stage II: solve the task using the MathCAD package; Stage III: prepare an analysis of the results and prepare a report of small groups.

The methodological value of completing tasks of this kind lies, first of all, in the fact that students form not only stable mathematical knowledge, but also the ability to apply methods of solving problems in real situations.

CONCLUSIONS

The essence of the mathematical problem is revealed as the main means of forming the competence of students of technical universities and the relevance of addressing the problem approach in the learning process is shown, and a methodology for the formation of key competencies through the solution of technological problems has been developed and proposed.

Thus, as our experience and analysis of specialized literature shows, in order to form a technical university among students, professional competence through the discipline "mathematics" requires a more active use of the problematic approach, which allows one to form the ability to solve professional problems through mathematical modeling, the ability to establish connections between mathematical knowledge and the content of courses of special disciplines.

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