Formation and Measurement of Professional Competencies in Technical University Students

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Abstract: The article explores ways and methods to enhance the quality of training for graduates in the field of "Oil and Gas" through the implementation of a competency-based approach in modernizing the content of professional education. The article provides a rationale for a task-based approach application in professional competencies formation in technical university students of and examines the experience of implementing this approach. The authors emphasize the importance of the discipline "Mathematics" as the basis of professional training, with particular attention given to defining types of competencies and developing bachelors' general professional abilities, with a focus on reflecting the problems that arise in developing educational materials in accordance with the requirements of the third-generation state educational standards. This article analyzes the basic concept of "task" and proposes an author's understanding of the term. The author presents the experience of developing practice-oriented tasks for technical university students. The experience of implementing this technology in the study of the discipline "Mathematics" at an oil technical university in accordance with the requirements of third-generation standards is discussed. Special attention is given to the technology of forming professional competencies in technical university students. This article outlines the stages of organizing the learning process in task-based approach to education implementation. The methods of organizing the formation of professional competencies are examined using specific examples. The author reveals the essence of a mathematical problem as the main means of developing the competency of students in technical universities, demonstrates the relevance of using a task-based approach in the learning process, and proposes a specific methodology for developing key competencies through the technological tasks solution.

1 INTRODUCTION

The process of forming mathematical competency in future engineers determines their preparation for technical activities related to the ability to solve real production tasks.

The concept of "task" is one of the fundamental concepts of mathematics. Currently, there are different approaches to interpreting this concept.

In the broadest sense, a task can be interpreted as a goal that needs to be achieved, as a question that requires a solution based on certain knowledge.

Analyzing different interpretations and definitions of "task" it can be noticed that it is largely determined by the relationship between the concepts of subject and task.

Supporters of the interpretation of a task as a situation in which a subject must act explicitly include the subject in the very concept of a task. In their works, Y.M. Kolyagina and G.I. Sarantseva note that without a subject, there is no task, and what may be a task for some may not be a task for others (Kuprich, 1995).

L.M. Friedman defines a task as a model of a problem situation expressed using signs of some

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artificial and natural language, considering the problem situation as the initial one.

In his works, A.M. Leontiev considers a task in which all components are mathematical objects solved by a mathematical apparatus (Kolyagin, 1977).

In conclusion, it can be inferred that the representation of tasks depends on the field of knowledge it reflects. When using this term, it is necessary to indicate what content is attributed to the concept of "task".

The main characteristic of a task is the temporary absence of ways to solve it, i.e. the absence in the learner's consciousness of a logical sequence of specific operations connecting the task/s condition with its requirements 4.

At this stage, it is important to note that S.F. Dorofeev considers a task as a specific situation of the subject-object category that needs to be resolved taking into account the conditions specified in it. We adhere to the viewpoint of Yu.M. Kolyagin, G.I. Sarantsev, L.M. Friedman, S.N. Dorofeev, and understand the task as the activity of the subject, which is a system of problem-solving processes consisting not only of normative, but also creative components of activity, not only externally represented, but also related to the aspirations of the individual.

2 MANUSCRIPT PREPARATION

Based on the above, we believe that the formation of professional competence is possible through solving tasks that represent the synthesis of subject-specific and professional conditions.

We have made a certain contribution to the discussion on the implementation of the principles of the competency-based approach in the preparation of bachelors in technical specialties.

Currently, there are obvious problems in the implementation of the main educational bachelor's programs, that is, the process of competency-based education, which include: the lack of methodological tools for forming and assessing the competencies of graduates, and the development and implementation of a system of objective diagnostic educational procedures.

The goal of the research is to propose a solution to the problem associated with the formation and assessment of the level of acquired competencies in the implementation of the main educational program of the bachelor's degree in the field of 21.03.01 "Oil and Gas Business". The study was conducted using the example of mastering the discipline "Mathematics". Then, substantive models of the process of forming and assessing the most significant general and professional competencies of the type OK-1; PK-1; PK-2; PK-4; PK-6 7 are considered.

From our point of view, the technology of teaching students to solve mathematical models of professional tasks should be carried out step by step; namely:

- At the first stage, algorithmic tasks should be considered;
- At the second stage, tasks at the heuristic level aimed at developing the skills to solve technological problems should be addressed;
- Finally, at the third stage, tasks should be used that are aimed at developing the skills to solve applied practical problems at a generalized level.

The task-oriented approach in implementing the competency-based approach is combined with the synergy approach. Synergy, as V. Milushev notes, shows that the path to the future for complex nonlinear developing systems, such as future professional activity, is always non-unique (Milushev, 2009). Thus, organizing learning in the context of the synergy approach leads to the development of the self-learning ability of the "how" type. The degree of cognitive independence of the learner, the ability to use fundamental knowledge in their professional activity, depends on whether the following skills are developed, such as:

1) identifying the problem in the task and understanding it;
2) formulating ways to solve this task;
3) justifying the ways to solve this task;
4) applying the found solution method in practice.

These skills can be acquired in the process of learning mathematics, based on a methodological system aimed at developing professionally-oriented skills. Our mathematical system corresponds to the basic principles of synergy, as in addition to the properties of free self-development, self-organization, viability, it also requires properties of non-equilibrium, instability, nonlinearity, etc.

Solving professionally-oriented tasks pushes students to a point of bifurcation, giving impetus to the search for a way out of their previous, stable knowledge towards something new - this is the path of self-development.

In our opinion, it is the task-oriented approach in mathematics education that promotes the development of students' synergistic action, driven by their desire to increase the level of their knowledge taking into account their own abilities and capabilities.

Synergy allows us to rephrase questions, reconstruct problems, which allows for a qualitative preparation of students.

Let's take a closer look at the technology of forming professional competence PC-1 "acquiring new knowledge independently, using modern educational and informational technologies".

Organization of the process: solving a task of technological content, for example, after studying the theoretical material on the theory of probability 7, tasks of this type are proposed: "In an oil-bearing region, 6 wells are drilled simultaneously. Each well opens reserves independently of the others with a probability of 0.1. What is the probability of discovering reserves? How many wells need to be drilled for the probability of discovering reserves to exceed: a) 0.7; b) 0.8; c) 0.5; d) 0.9?"

Teaching methodology:

The main stages of organizing learning according to the scenario of the business game “Conditional Probability. Probability of at least one event occurring from a complete set of events”.

Stage I. Checking and consolidating the level of students’ knowledge on questions related to the content of this topic.

Stage II. Choosing formulas and solution methods. Collective discussion of solving the problem in groups. (Participants are divided into small creative teams (3-5 people), each group solves their own variant).

Stage III. Solving the problem in small groups, preparing presentations for discussing the solution to the problem. Monitoring the work of each participant with assigning and explaining grades for individual work.

Stage IV. Solution to the subproblem: evaluate the impact of one of the criteria for the probability of deposit discovery. Discussion of results with scoring.

Stage V. Summing up the game, analyzing mistakes, reasons for awarding punitive and encouraging points. Discussion of final evaluations.

Setting tasks of this type allows finding ways to solve them and forming competences based on existing theoretical knowledge.

Another method of forming professional competence PC-4 “mastering the main methods, ways and means of obtaining, storing, processing information, working with a computer as a means of information management” is to perform laboratory work in the form of technological tasks 7,8, using a package of computer programs for performing and analyzing the results of computational experiments, such as “Based on geological data of the Bavlinskoye field, calculate oil reserves and changes in average formation pressure within the oil reservoir.”

Teaching methodology:

Stage I: study the results of geological surveys and determine calculation methods;

Stage II: solve the assigned task using the MathCAD package.

Stage III: prepare an analysis of the obtained results and prepare a report for small groups.

The methodological value of completing tasks of this kind lies primarily in the fact that students acquire not only solid mathematical knowledge, but also the ability to apply problem-solving methods in real situations.

Thus, our experience and analysis of specialized literature show that in order to develop the professional competence of students in a technical university through the discipline of "mathematics," it is necessary to more actively use a problem-based approach that allows developing the ability to solve professional tasks through mathematical modeling and establishing connections between mathematical knowledge and the content of specialized courses.

3 CONCLUSIONS

1. A methodology for the formation and evaluation of the level of knowledge, skills, and acquired general and professional competences of Bachelor's degree graduates in technical specialties has been developed.

2. The methodology is based on the following principles:

- Maximum approximation of the object of educational and scientific research to future professional activities using technical content tasks.
- Comprehensive use of mathematical modeling methods and performing computational experiments with the help of well-known mathematical packages.
- Organization and conduct of interactive forms of the educational process with the identification and support of self-analysis and self-diagnostics processes.

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