PROFESSIONALLY ORIENTED MATHEMATICAL TRAINING OF STUDENTS IN HIGHER EDUCATIONAL INSTITUTIONS

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Abstract

The article considers the problem of mathematical training of students in the higher educational institutions, as well as professionally oriented training as one of the ways of its solution. There are the results of international programmes on the assessment of the quality of TIMSS and PISA educational results among Russian students in the field of Mathematics, as well as their interpretation. The author suggests the design and introduction of an adaptive system of mathematical training in the university, taking into account the professional orientation of educational material on Mathematics depending on the student's training areas. In the framework of the system there are the requirements for the mathematical competence of students, the content of mathematical training and professionally oriented tasks. The main functions of the developed adaptive system are presented.

Keywords: professionally oriented education, Mathematics, adaptive system, student, higher educational institution.

1. INTRODUCTION

In conditions of the widespread modernization of the social and economic system of Russia the problem of improving mathematical training of students in the system of higher education is becoming more and more important and requires deep scientific understanding both at the theoretical and practice-oriented levels. The analysis of normative as well as research and methodological sources revealed that in recent years the role of Mathematics in the modern science and education is increasing rapidly. The understanding of the need for a high level of mathematical training to perform the tasks on creating an innovative economy and implementing long-term social and economic development of the country is formed more clearly.

Today the most productive and promising educational technologies are professionally oriented ones, which allows to arrange the educational process taking into account the field of expertise and being oriented at student's personality, their interests, vocation and abilities.

In spite of sufficient research in the field of implementing the adaptive system of teaching Mathematics, there is an urgent need for the development and implementation of adaptive systems and mathematical training that meet the requirements of the Federal State Educational Standards of Higher Education reflecting the fundamental principles of Mathematics and taking into account the specific character and the peculiarity of the future professional activity of students.

2. THE PROBLEM OF PROFESSIONALLY ORIENTED MATHEMATICAL TRAINING OF STUDENTS

In accordance with the Concept of the Development of Mathematical Education in the Russian Federation approved by the Decree of the Government dated December 24, 2013 No. 2506-r, "the study of Mathematics plays a crucial role in education developing cognitive abilities of a person including logical thinking, as well as influencing the process of teaching other subjects. Qualitative mathematical education is necessary for every person in their successful life in the modern society" (Concept, 2013, p.2). This emphasizes the situation of isolation of mathematical education in universities from the modern science and practice, fall of its level, lack of a mechanism of timely updating of its content.

To complete the study of this problem, let us consider the international programmes of quality assessment of educational outcomes TIMSS and PISA which allow to detect and to analyze the peculiarities of the Russian system of education. The differences between the programmes are as follows: TIMSS measures learning outcomes or achievements based on the results of previous learning and is a consequence of it (Trends, 2018), while PISA considers learning outcomes as a basis for further development (Programme, 2018).

Tasks in TIMSS are classified among three groups: determination of the level of subject knowledge (rules, procedures, and algorithms), possession of types of cognitive activity (training and application tasks solution, determination of cause-effect relations, application of knowledge in practical situations), and reasoning (justification of solutions, application of knowledge in unfamiliar situations, dealing with complex and multi-step tasks). The analysis shows that the dominant cognitive activity of junior schoolchildren is reasoning and application, but, unfortunately, by the 8th grade there is a clear dominance of a knowledge component. At the same time, the level of mathematical training of eighth grade students in general is below the level of fourth-graders as per average score.

According to the results of PISA–2015, Russian students in terms of mathematical literacy take 20-30 places, gaining 494 points; while in PISA–2012 they take 31-39 places (482 points) among the 65 participating countries. The research uses the term 'literacy' for the ability to solve real-life problems backed by subject knowledge.

According to the experts the results of the Russian eighth-graders (TIMSS) and 15-year-olds (PISA) have a unique interpretation: a good level of mathematical knowledge and inability to use them due to unpreparedness of students of Russian schools to perform practice oriented tasks. Tasks aimed at analysing and justifying the data, their application in unusual situations, and explanation of the problems of the surrounding reality cause the greatest difficulties among students.

A detailed analysis of the Concept (2013) showed a lack of elucidation of the need to implement the applied and professionally oriented focus of teaching Mathematics at all levels of the educational system. Sections of the document superficially touch upon the topic of the need to increase the level of mathematical knowledge and skills used in everyday life and professional activities.

An urgent problem of isolation of the contents of mathematical education from the future professional activity of graduates is obvious. Currently higher educational institutions often present the educational material using theoretical and formal and logical character, but the very content of mathematical knowledge remains mostly isolated from the professional subjects, and the students do not have necessary motivation.

In addition, rapid development of information and telecommunication technologies lead to a constant obsolescence and change of mathematical apparatus, new opportunities for modeling and design of professional tasks. All this requires continuous updating of mathematical content and bringing it into conformity with the social demand of society.

One of the ways to solve this problem is the design and implementation of an adaptive system of mathematical training in the university, taking into account the professional orientation of educational material on Mathematics depending on the student's training areas. The focus of teaching Mathematics on the professional activity is a key to a successful and high-quality training of students at the university, their orientation to the future qualification.

3. ADAPTIVE SYSTEM OF MATHEMATICAL TRAINING OF STUDENTS

Professional orientation of the content of teaching Mathematics contributes to the resolution of the contradiction between the abstraction and isolation of mathematical knowledge acquired at the university and their application in future professional activities. In addition, professionally oriented focus includes such tasks as the formation and the development of mathematical competence, the development of scientific world

outlook, intellectual development and, consequently, improving the quality of professional training of students.

Let us consider the development and implementation of adaptive systems and mathematical training of students.

T.L. Anisova describes a model of the adaptive learning system in the technical university within the framework of teaching Mathematics for the bachelors applying teaching methods with the use of summary tables, reference drawings, animated learning tasks (Anisova, 2013). T.E. Chikina when designing an adaptive system for future teachers of Mathematics uses a design workbook for the practical sessions, process flow diagrams and diagnostic materials designed for operational control and monitoring of students' progress (Chikina, 2009).

E.V. Smirnova proposes an adaptive system of teaching Mathematics for the first-year students, which is based on the author's express cards Mathcad, arranging students' work in pairs and micro-groups at their own pace, a three-level teaching monitoring, educational consulting (Smirnova, 2004).

O.N. Berishvili considers the adaptive system of mathematical training of engineers in agricultural universities based on a set of teaching tools that encourage the development of abilities to use in the future professional activity the methods of optimal decision making which are adequate for the strategy of developing agricultural production in market conditions (Berishvili, 2015).

The content of teaching Mathematics in a professionally oriented aspect is mostly adapted through the solution of professionally oriented tasks. There is no such professional area where there would be no need to apply mathematical knowledge. Mathematics has become a widespread tool of research in Astronomy, Physics, Chemistry, Biology, Engineering, Military Art, Sociology, Economics, Law, Factory Management and many other fields of theoretical and applied spheres. Many experts in the field of medical and biological, as well as social and humanitarian research believe that the future progress of their subjects is closely associated with the broader and full-scale application of mathematical methods for the solution of professional problems than it was before.

3.1 Requirements for the Structure of Mathematical Competence of Students

The regularities for building the adaptive systems for mathematical training of university students with the purpose to promote personal and professional development of future specialists include:

– preserving fundamental mathematical training of students of higher educational institutions and strengthening practical orientation of educational content;

– meeting personal, professional and social needs of students in mathematical knowledge, skills and competences;

– adapting to the specific conditions of the learning process depending on the individual characteristics of students, taking into account the subject-personal and professionally-oriented integration of the training courses.

At the same time the structure of mathematical competence from the perspective of the professional orientation of the training content should include the following skills:

– the ability to stream / transfer tasks from the professional language to mathematical tool;

– the ability to choose methods and means of solving such problems;

– the ability to build mathematical models describing real processes of the professional sphere, to interpret the results.

3.2. Requirements for the Content of Mathematical Training of Students

When designing an adaptive system of mathematical training of students in higher educational institution it is necessary to implement the following linear structure of presenting the educational material in Mathematics:

1) familiarising with the general theoretical part;

2) studying the complex of methods to solve the tasks on the topic;

3) considering situations and assigning tasks of future professional activity depending on the major/ profession of a student;

4) applying the studied methods for the solution of professionally oriented tasks.

Thus, necessary requirements for professionally oriented tasks which contribute to the formation of mathematical competence of students are the following:

– the task should include a description of the situation arising in the professional activity of students depending on their major/ profession;

– the task should have the property of structural completeness, i.e. it should be built taking into account the principle of integrity;

– the task should contain unknown characteristics of some professional object or process to be studied / calculated / found using the tools of Mathematics;

– the content of the task and its solution should rely on the knowledge and skills of professional subjects, thereby to ensure the acquisition of the relationship between mathematical and professional subjects;

– the solution of the task should lead to a stable acquisition of mathematical competences, techniques and methods that are the basis of the professional activity;

– the solution of the task should provide intellectual and professional development of the personality of future specialist.

3.3. The Functionality of the Adaptive Teaching of Mathematics

The proposed adaptation system of teaching Mathematics on the basis of professionally oriented content performs the following functions:

– *training*, directed to the formation of mathematical competences, abilities and skills of students for solving tasks in the professional sphere, acquiring the mechanism of mathematical research and modeling;

– *developing*, promoting students' acquisition of effective techniques of learning activities, the development of logical and analytical thinking, the formation of concepts and models of mathematical objects, students' worldviews;

– *educational*, aimed at the formation of professionally important qualities and human culture, the development of cognitive interest, the formation of the ability to interpret their point of view, the development of the ability to overcome difficulties, respect for education;

– *applied*, contributing to the ability to carry out modeling and calculations, construct models of reality and interpret the results, develop the ability to use the mathematical approach for solving tasks of professional orientation, and decisions on their basis.

The implementation of such adaptive system will contribute to the effective formation of professionally oriented knowledge and skills providing:

– acquisition of mathematical knowledge in conjunction with their applied and professional interpretation;

– ability to build mathematical models of real processes from the professional sphere;

– developing a mathematical foundation for the study of professional subjects;

– personal creative self-fulfillment.

The formation of the process of teaching Mathematics in this way will allow to solve a number of educational problems all together that were previously solved separately in various professional areas, and thereby show the future specialists how the gained combined complex knowledge is transformed into the professional activity.

This model was the basis for an adaptive system of mathematical training of students in conditions of electronic information educational environment of the Chair of Applied Mathematics and Computer Science of the Mari State University (Toktarova, 2017).

4. CONCLUSION

To sum up, it must be emphasized that the specificity of mathematical training of students in the University in conditions of an adaptive system should be based on the priority of a student. Mathematical knowledge should be considered, first of all, as a means of personal development and then as an object of study. This model allows to build mental activity of each student in accordance with their individual characteristics and

future professional activity, which is achieved by clear definition of goals and phases of activity, methods and tools, learning content and educational technologies.

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