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PROBLEMS OF DEVELOPING MATHEMATICAL COMPETENCIES OF FUTURE ENGINEERS

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ABSTRACT

In the article, the question of improving the formation of mathematical competencies of future engineers on the basis of a fast-paced approach is developed, in particular, the main concepts, the main issues of the topic, which includes the methods of activity for solving these issues. The need for the development of mathematical competence that increases intellectual base of a competitive specialist in modern society is determined in the article.

Keywords: mathematical competencies, theoretical and practicing mathematics, engineering education.

Nowadays, the natural sciences, based on mathematics, play an important role in the training of engineers. The concept of competence or competency is a substantive generalization of theoretical and empirical knowledge presented in the form of concepts, principles and system-forming provisions [7]. The main component of professional competence is mathematical competence, which was studied by such scientists as L.V.Vasyak, V.V. Poladova, S.A. Tatyanenko, and others. The professional competence of a future engineer depends on the quality of mathematical training based on mathematical competence.

Competence also means that a person has the appropriate competence, which consists of competency and personal attitude to the subject of activity. N.A.Muslimov described competence as follows: "Competence is characterized by the acquisition of knowledge, skills and abilities necessary for the implementation of the student's personal and socially important professional activities and their ability to apply them in professional activities" [1,2].

The solution of many tasks in various field of the state activity, no matter if it is economic, intellectual, military or any other activity, largely depends on the level of knowledge and qualification of personnel. Therefore, the issues of training and improving the talent pool are of high priority, which resulted in the inclusion of a competency-based approach

into the system of education. This component provides for the development of business qualities, independence in solving various problems and is aimed at students' ability to gain, advance and apply the acquired knowledge both in the educational process and in real life situations. Engineering field of studies requires deep knowledge of mathematics, which is a fundamental aspect for many disciplines. Is also contributes to the fundamental system of students' training during the period of study at the university. Moreover, the development of technology and digital resources has led to new possibilities for engineering work in which mathematically complex problems are solved with computer support, and visualizations and simulations play a central role. These developments have also changed the conditions for teaching and learning. The new technologies make it possible to solve (beside special, simplified problems) also complex realistic problems and to visualize solutions, phenomena and theoretical aspects. New information technology also makes it possible for students (and instructors) to work at a distance, particularly in the recent pandemic. However, sustainable innovative changes have to be backed up by research. We observe a growing number of research studies on mathematics in and for engineering in recent years.

The focus of this paper is to provide a state of the art overview of this emerging field at the cross-roads between mathematics and engineering education. We pose the following guiding questions for our review:

1. How can current (teaching/learning/study) practices of mathematics in engineering education be characterized with a view towards innovation?

2. What are the "resources" (cognitive, material, digital, social) used, and what are those that appear also well suited for innovative courses?

3. What are promising innovative practices in engineering education, and what are the implications for curriculum reform?

We contend that reviewing the existing research literature with a view towards informing and documenting promising innovative practices in engineering education is likely to support the identification of 'unknown territories' in mathematics education, as well as assist to link mathematics and engineering education more closely.

Views of the instructors can differ in terms of what kind of mathematical practices and how the relevant content should be taught to future engineers. These practices will vary from one instructor to another. Since students meet many instructors, this can cause difficulties for them to build a coherent web of knowledge, in particular regarding high-level

mathematics. Therefore, a deeper understanding of the variability of different curricular practices is necessary for addressing innovation concerns.

A deeper understanding of current practices should also include a focus on student views and affect. Research studies approach this from an analytical perspective to first better understand engineering students' views. Others approach it from an innovation perspective, as for the enhancement of mathematics in engineering education research needs to address student learning, including their study and learning behavior.

Reviewing the literature considering the use of program in mathematics education for future engineers, we identified two issues:

1. Some studies consider digital tools and their use for mathematical problem solving as an essential new skill for future engineers, and ask which activities afford the learning of such new skills. This is a completely different perspective from using digital tools as a means to improve learning.

2. If we regard digital tools and their use as a way to enhance mathematical learning, we would ask questions concerning how technological tools could be integrated in courses for future engineers. The answer to this question depends on the kind of tool used, and on the aims of the course.

As it is noted by R.S. Pionova, the fundamental character of education 'can be ensured by fundamentalization of knowledge throughout all disciplines of general scientific, general professional and special training of students' and as a result 'the main features of fundamental knowledge and education content should be the integrity of perception of the scientific picture of the world; the disclosure of the essence of facts in the studied field; the development of ability to synthesize knowledge from different fields; the formation of interdisciplinary knowledge; a high level of flexibility, contributing to understanding the essence, the interrelation of facts and phenomena from various fields of science and practice' [4, p. 91].

According to N.A. Kazachek mathematical competence is represented as an integral property of personality expressed by deep and solid knowledge in mathematics, the ability to apply existing knowledge in a new situation, ability to achieve significant results and quality in the activity. In other words, mathematical competence presupposes a high level of knowledge and experience of independent activity on the basis of this knowledge [5].

In the opinion of V.G.Plakhova the mathematical competence of students studying at engineering universities is the ability of the students to apply the system of acquired

mathematical knowledge, skills and abilities when studying mathematical models of professional problems, including the ability of logical thinking, evaluation, selection and application of information, as well as making independent decisions [6].

To summarize the main results in this section, we identified four themes. First, modelling appears to be one of the main areas of mathematics that speaks to engineers: it helps to make the mathematics relevant for engineering students, and it helps the sense-making of the engineering problem, and not stay at the level of 'calculating'. At the same time, it is perceived to be difficult because after the sense making of the situation, the situation needs to be 'mathematised', that is put into mathematical language), and students often fail to see its value. Second, most innovative teaching and learning practices aim to empower the student for actively taking charge of their own learning (more than in traditional courses), becoming self-regulated, and developing their own study paths. Hence, these are all practices of a student-centered curriculum. Third, it appears that varying the learning strategies over the course worked well for students. In particular, open questions seemed to activate and engage students rather than multiple choice questions, and active learning in turn increased attainment in examinations. Fourth, regarding assessment practices, formative assessment seemed to be beneficial for learning mathematics in engineering education, and feedback was one of the main components here, in particular feedback on tasks and the processes of solving the tasks.

Experiments and observations show that students studying in the field of industrial and technical education have a very low level of mathematical knowledge. Higher mathematics is not at the level of full mastery of the science program. Students are not able to apply their existing mathematical knowledge to general and specialized subjects. This, of course, has a negative impact on the quality of training of highly qualified engineers. The importance of higher mathematics in the training of engineers, technologists, economists is clearly defined in the goals and objectives of science teaching.

The goals and objectives of teaching higher mathematics to students in the relevant undergraduate disciplines of higher education are clearly defined. The goal of the course is to help students acquire and apply the necessary mathematical knowledge to help them analyze, model, and solve engineering, technological, and economic problems. The task is to develop students' skills in logic and algorithmic observation, mathematical problem solving, verification methods, independent development of mathematical knowledge and applied mathematical analysis and solution of engineering, technological

and economic problems. So it is not enough to study certain theorems in mathematics. It is clear that it is important to pay more attention to the applied side of science [12].

It is well known that mathematics, while being a fundamental, theoretical science, has been repeatedly proven by our leading scientists to represent the processes that take place in nature and to have a wide range of applications. If we look at the history of the development of the science of mathematics, it has been applied for thousands of years to solve various problems encountered by human society and science and technology [13].

Based on the above, in higher education in the areas of education, such as engineering, manufacturing, technology, economics, — General education, engineering , focusing on the application of specialty sciences has a positive impact on the quality and effectiveness of education [14].

Experiments and observations show that students studying in the field of industrial and technical education have a very low level of mathematical knowledge. - Higher mathematics is not at the level of full mastery of the science program. Students are not able to apply their existing mathematical knowledge to general and specialized subjects. This, of course, has a negative impact on the quality of training of highly qualified engineers. —The importance of higher mathematics in the training of engineers, technologists, economists is clearly defined in the goals and objectives of science teaching.

The goals and objectives of teaching higher mathematics to students in the relevant undergraduate disciplines of higher education are clearly defined. The purpose of the subject is to provide students with the necessary mathematical knowledge to apply, analyze, model, and solve engineering, technological, and economic problems. The task of science is to develop students' skills in logical and algorithmic observation, mathematical problem solving, verification methods, independent development of mathematical knowledge and applied mathematical analysis and solution of engineering, technological and economic problems. So it is not enough to study certain theorems in mathematics. It is clear that it is important to pay more attention to the applied side of science.

Based on the above, attention is paid to the application of general mathematics, engineering, specialty sciences in the teaching of higher mathematics in the field of education, such as engineering, production, technology, economics focus has a positive impact on the quality and effectiveness of education.

At the Faculty of Transport of Jizzakh Polytechnic Institute, experiments were conducted in randomly selected groups with almost the same level of knowledge in mathematics in the field of Road Engineering and Vehicle Engineering. They were designated as experimental and control groups. In the experimental groups, practical training in higher mathematics was conducted on the basis of an innovative approach. The course focuses on general and specialized subjects taught in this field of study.

In particular, the study of the topic of matrices, the construction of equations of state of road construction systems, the study of the derivative and differential section of science, the speed, acceleration, maximum and minimum values of various vehicles; distance of travelling in the study of topics related to the exact integral section, the work done by the force, kinetic energy; in the study of topics related to differential equations, the solution of problems related to the solution of action differential equations has been shown.

In addition, in the process of teaching subject, more attention was paid to the independent work of students, as well as the solution of applied problems of students in the field of general and specialized disciplines. Talented students participate in scientific conferences mainly on topics related to the application of mathematics in engineering.

In the control and experimental groups, mastering of the subject was monitored and the results were compared. The quality and effectiveness of student in experimental groups taught on an innovative approach has increased significantly.

Innovative teaching also has the following advantages:

- Students will have the skills to use mathematical devices in the study of general and specialized subjects, course work, graduate work, and then in research work;

- Interdisciplinary communication is improved, and as a result, the quality of study in general and specialized disciplines has a positive impact;

- Students realize that the science of higher mathematics is not only a theoretical science, but also has a wide range of applied features, and their interest in in-depth study of science increases;

- The share of qualified personnel with the skills of mathematical logical analysis and modeling of production processes will increase.

Of course, the above innovative methods increase the quality and efficiency of teaching. To do this, we consider it necessary to solve the following problems:

- It is necessary to create textbooks for the departments of the Higher Mathematical Course, indicating the applications of engineering, technology and economics in solving problems related to general and specialized disciplines;

- In the training of future engineers in the process of teaching the theory of mathematical sciences and the solution of theoretical problems, it is desirable to teach how to apply it to the solution of practical problems;

- It is necessary to strengthen the relationship between the fundamental, general and specialized disciplines.

In conclusion, in such an innovative environment, a higher education institution should consider:

1. Mathematics teachers should not only rely on their own experience in teaching and learning (in traditional ways) but should be encouraged to ask: “practical” or “problematic” in the teaching of mathematics in engineering courses “What does learning mean and how can I design, teach and evaluate such learning? How can I use (or design) useful and effective use of educational technology and digital resources to increase student engagement and learning? It takes time and resources and institutional support to develop and implement these considerations.

2. Students may come to class not to listen to a lecture, but to work with their peers in the field of innovation, and to learn math mobile using a variety of devices (including iPads; mobile phones), or outside of class, traditionally different methods of engagement and ways of learning may be required than intended.

3. Traditionally, mathematics education is expected to provide the necessary knowledge for an engineering curriculum because it provides basic mathematical knowledge as well as good analytical and problem-solving skills that are often required in traditional engineering work. said to lay the foundation for their marriage. With the recent and emergence of digital technologies, the following goal for engineering education and mathematics is growing: the ability to interpret the meaning of mathematics in engineering. This is especially important when using computer programs. Special applications offer approaches that help and support students in developing problem-solving skills. Digital resources and educational technologies (such as virtual reality) can help solve such problems. In this sense, mathematics becomes a source of inspiration for engineers because it offers mathematical structures that become potential solutions to engineering problems.

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