

## ON INTERACTION OF SCHOOL AND UNIVERSITY IN THE FRAMEWORK OF ENGINEERING EDUCATION

**Vinogradov, Valentine V.**, Russian University of Transport, Moscow, Russia.

**Kochneva, Ludmila F.**, Russian University of Transport, Moscow, Russia.

**Platonova, Olga A.**, Russian University of Transport, Moscow, Russia.

### ABSTRACT

The article discusses the problems that arise when engineering classes are organized in secondary schools with participation of universities, and ways to solve them. To strengthen the connection between the school and the university, it is necessary to use both methodological and technological capabilities. The analysis of topics close to the standard programs of higher engineering education, which

have appeared recently in the school curriculum in mathematics, is carried out. Methods have been proposed for wider engagement of intellectual capacity of university staff by involving them in creation of teaching methods in schools and especially in the in-depth study of mathematics in engineering classes. The experience of a special mathematical seminar organized by university departments of mathematics for school teachers of engineering classes is considered.

**Keywords:** engineering education, interaction between school and university, professional competence of teachers, teaching methods, mathematical seminar, curriculum.

**Background.** The urgent demand of the society to increase the number of engineers for intensive development of the country's economy leads to the need for structural and technological changes in organization of secondary general education. The principle of division of classes into conditionally humanities and conditionally mathematical ones becomes insufficient. This division should be made in a more precise manner, and the content of education itself within the framework of state standards should be more focused on results. Such a need contributes to creation in schools of so-called engineering classes aimed at training pupils who are focused on future work in industry and on obtaining stronger mathematical, physics skills and general technical knowledge.

**Objective.** The objective of the authors is to consider different aspects related to the interaction of school and university in the framework of engineering education.

**Methods.** The authors use general scientific methods, comparative analysis, evaluation approach.

### Results.

#### I.

At the present stage of development, higher education is confronted with a specific challenge of particular importance – establishment of closer interaction with the secondary school in all its multifaceted activities – from educational to pedagogic. The attention that the government is paying to training of high-quality engineering personnel concerns not only universities, but also strengthening of communication between them and secondary schools. An introduction to the practice of engineering classes is a direct demonstration of this attention. The task of schools is to attract students to such classes and organize decent training that will facilitate their choice of an engineering specialty. This is not an easy task, especially if we take into account shortcomings of school educational programs in natural sciences and their lag behind the level of knowledge necessary for successful continuation of studies in higher school.

The reforms of recent years are aimed at creating integrated educational centers, where it is possible to study using innovative technologies, all other resources of higher education. From this point of view, school programs in mathematics are beginning to include more and more topics that are typical for standard programs in higher engineering education. This becomes an additional incentive to use the pedagogical and intellectual potential of university employees by involving them in creation of teaching methods in school and, above all, in the in-depth study of mathematics in engineering classes [1, pp. 142–147; 2, pp. 163–165; 3, pp. 120–124].

Particular attention should be paid to the enhancement of mathematics education in school with innovative technologies, the use of the Internet network and other methodological techniques.

For example, tasks in mathematics were introduced in past years, and then their complexity increased, that include the elements of probability theory, and use not only the initial combinatorial tasks, but also the concepts of addition and multiplication of probabilities, the total probability formula – and this is not the material of even the first course of study in higher school. In the school curriculum, however, there is practically no consideration of the standard concepts of combinatorics, which develop thinking and gradually bring the student to the concept of «probability». Tasks in probability theory are recommended to be solved by analogy with those presented in preparatory mathematical collections, and that approach cannot be considered methodically correct. In any course of probability theory in higher school, this material is presented conclusively and in detail only during the third semester of study, after passing the fundamentals of mathematical analysis and higher algebra. And all the tasks of moving the beetle along branches and the like, it turns out, can be solved using common theoretical approaches.

The complexity of the tasks of financial and mathematical nature increases, as external economic reality requires a person to understand various financial processes and to get the ability to calculate their actions. Nevertheless, pupils should first get a basic knowledge of finance, and not guess how to solve various text tasks. University lecturers would be able to organize on an ongoing basis useful courses for both pupils and teachers. If, for example, they were explained the concept of financial rent, then many modern, rather cumbersome financial problems can be solved elementarily in one action, but first you need to find out what is at stake and how to understand the condition correctly.

Moreover, elements of linear programming, which will not appear in universities for all students and not in the first year, appear in publications recommended for self-preparation of schoolchildren. Such manuals offer a partial and inconsistent approach to solution of (sometimes even intuitive) individual tasks, while in school textbooks there is no systematic presentation of the corresponding theory.

Let us note that school teachers who teach in engineering classes also need to receive methodical knowledge in emerging disciplines in order for the learning process obtains new content and leads to better results, and later to better learning at the university. Both of these problems appeal to the rich potential of Moscow

universities, which can provide decent and multilateral support to schools.

## II.

The presence of problems is clearly seen by the Department of Education of the city of Moscow, which for several years has been allocating grants for projects related to strengthening of school-university interaction. We note that Russian University of Transport has long and fruitfully cooperated with the department on this issue.

Back to 2013, work was carried out on development of interaction of the university with schools of the Northeastern District Education Department of the capital. Employees of mathematical departments at the request of the department created an additional professional program and conducted seminars on implementation of specialized education for teachers of engineering classes.

The objective was to develop professional competencies of teaching staff implementing secondary education programs for pupils in specialized classes. In the process of creative cooperation of teachers of city schools and the university, the complementary professional programs in engineering education in mathematics, including test and measurement materials for organization of intermediate and final certification of students were developed.

We believe that the time has come to build on a permanent basis an effective creative team of lecturers of mathematics of the University and of teachers and mathematicians of the city schools (not necessarily within the limits of the North-Eastern Administrative District) in order to improve the quality of mathematical education in engineering classes [4, pp. 254–258]. Such a measure would allow raising the level of professional competence of pedagogical staff implementing programs of secondary general education for students of engineering classes, as well as introducing innovative technologies into the educational process to maximize disclosure and support of students' abilities.

When creating a system of effective school-university interaction, both the high competence of mathematics teachers and updating of methodological tools based on innovative technologies previously used only in higher education are required. Such techniques as access to the Internet portal, for example, where lectures on interesting topics, methodological developments, versions of solved tasks, tasks for independent control, and so on, can be accessed. A schoolboy can listen to the same video lecture as many times as he needs to fully master the material, and he can do it both at school and at home. The same possibility will be suggested for solving different tasks.

Working with a computer is familiar to a modern student, he usually absorbs information well from the screen. In addition, it is easier to captivate his attention with «visually» entertaining presentation of the topic than with a correct, but verbose text.

We have proposed for consideration modular programs for additional specialized teaching of mathematics in engineering classes. They caused a general interest and can be applied by teachers in different ways, depending on personal educational plans. The programs are designed for students of 9–11 grades

and are focused on the textbooks of various authors. The work of a teacher with the use of such programs increases his competence in teaching methods, facilitates the process of drawing up an individual educational plan for the most advanced pupils.

When working with school teachers, special attention should be paid to such complex topics as task solving with parameters and non-standard methods of problem solving.

One of the planned seminars can be devoted to combinatorics and fundamentals of probability theory. It should be noted that since preparation for study in engineering class should already begin from 5–6 grades, and combinatorics requires ingenuity, and not knowledge of more complex subjects besides arithmetic, this is the topic with which it is easier to start classes with middle school pupils, if correct selection and task sequence are provided. The simplest tasks of probability theory, which are now being solved in secondary school, require a teacher to become familiar with the basics of the theory of probability and the basic concepts of statistics, without them the learning process is complicated. Communication with university professors helps to compensate for problems that may arise.

The seminar «Mathematics in real life according to the time – money scheme» seems to be very important. Such a meeting will be useful for understanding of the methods of solving problems related to fundamentals of financial calculations, including issues of financial flow and credit payments. We have developed an extensive teaching material, which contains presentation scripts, textual and test practical tasks.

**Conclusion.** Evaluation of such a multifaceted experience is, of course, ahead. But what has already been done, we believe, does not raise doubts about its relevance and prospects. Started projects need to be continued.

## REFERENCES

1. Vinogradov, V. V., Kochneva, L. F., Platonova, O. A. On improving the quality of mathematical knowledge. *World of Transport and Transportation*, Vol. 12, 2014, Iss. 4, pp. 142–147.
2. Platonova, O. A., Kochneva, L. F. The system of additional teaching of mathematics in a technical college [Sistema dopolnitelnogo prepodavaniya matematiki v tekhnicheskoy vuzel]. *Teacher of a higher school in 21<sup>st</sup> century: Proceedings of 11<sup>th</sup> international scientific and practical Internet conference*. Rostov-on-Don, RGUPS, 2014, pp. 163–165.
3. Platonova, O. A., Dmitrusenko, N. S., Pugin, L. V. On the mathematical training of future engineers [O matematicheskoy podgotovke budushchikh inzhenerov]. *Teacher of a higher school in 21<sup>st</sup> century: Proceedings of 13<sup>th</sup> international scientific and practical Internet conference*. Rostov-on-Don, RGUPS, 2016, pp. 120–124.
4. Platonova, O. A. University environment for teachers [Universitetskaya sreda dlya uchitelei]. *Teacher of a higher school in 21<sup>st</sup> century: Proceedings of 15<sup>th</sup> international scientific and practical Internet conference*. Rostov-on-Don, RGUPS, 2018, pp. 254–258. ●

Information about the authors:

**Vinogradov, Valentine V.** – D.Sc. (Eng), first vice-rector, professor of Russian University of Transport, Moscow, Russia, +7(495) 684–21–10.

**Kochneva, Ludmila F.** – Ph.D. (Eng), associate professor, head of the department of mathematics of Russian University of Transport, Moscow, Russia, m-miit@yandex.ru.

**Platonova, Olga A.** – Ph.D. (Physics and Mathematics), associate professor, head of the department of higher and computational mathematics of Russian University of Transport, Moscow, Russia, platonova\_o\_a@mail.ru.

Article received 16.11.2018, accepted 10.01.2019.

