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Застосування інформаційних технологій до математичної освіти ІТ-фахівців в англомовних академічних групах

Applying information technologies to mathematical education of IT specialists in English-speaking academic groups

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Знання основних теоретичних основ та володіння навичками застосування математичного аналізу, диференціальних рівнянь, лінійної алгебри, аналітичної геометрії, дискретної математики, чисельних методів, теорії ймовірностей та математичної статистики є важливими для професійної підготовки майбутніх фахівців у галузі інформаційні технології. Оскільки майбутні фахівці в галузі інформаційних технологій потребують глибокої математичної підготовки, навчальні програми ІТ-спеціальностей зазвичай містять різні математичні дисципліни.

Ця стаття присвячена вивченню деяких особливостей використання інформаційних технологій у процесі викладання окремих питань математичних дисциплін англійською мовою студентам ІТ-спеціальностей, які не є носіями цієї мови.

Ключові слова: викладання математики ІТ-спеціалістам, викладання математики англійською мовою, інформаційні технології.

Knowledge of the basic theoretical foundations and possession of the skills of applying Mathematical Analysis, Differential Equations, Linear Algebra, Analytic Geometry, Discrete Mathematics, Numerical Methods, Theory of Probability and Mathematical Statistics are important for the professional training of future specialists in the field of information technologies. Since future specialists in the field of information technology require a deep mathematical training, the curricula of IT specialties usually contain various mathematical disciplines from this list. A specialist of any IT profile must have specific professional features and competencies. These characteristics of future IT professionals should preferably be formed in the process of studying both special and general scientific disciplines. The result of the educational process is formation of both hard and soft skills of students.

This article is devoted to the study of some features of the use of information technology in the process of teaching some questions of mathematical disciplines in English to students of IT profile who are not native speakers of this language.

Key Words: teaching mathematics to IT specialists, teaching mathematics in English, information technologies.

Статтю представила к.ф.-м.н. Розора І.В.

Introduction

We present some results based on our experience in teaching mathematical disciplines in
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English-speaking academic groups of IT profile.

Knowledge of English is recognized as a basic life skill of the XXI century along with the ability to

use a computer, now it is no longer a separate specialization. English gives people the opportunity to work with a much wider variety of information, to get acquainted with more views than could be done in their native language alone. Implementation of education in English in Ukrainian universities contributes to their internationalization [1]. Therefore, training of foreign students is being introduced in many universities of Ukraine.

As English is one of the official languages of ICAO (International Civil Aviation Organization), the opportunity to receive professional education in English is very important for future professionals in the field of aviation. The program "Higher Education in Foreign Languages" began to work at NAU since 1999. Since a good knowledge of professional English is also important for future specialists in the field of information technology, soon students of IT specialties were also included in this program. Then the program has been extended to many specialties and is successfully operating to this day.

The teacher's work in English-speaking groups has a certain specificity, because for the vast majority of students English is not their native language. Certain features arise when working with groups in which both Ukrainian and foreign students study.

Research on teaching mathematics in English to foreign and Ukrainian students of NAU has been carried out within the framework of the Higher Education Program of NAU in a foreign language by a team of experienced teachers of the Department of Higher and Computational Mathematics since 2006.

Some of questions connected with teaching of mathematical disciplines in English to foreign students were investigated by authors in [2]. Beside this, authors studied teaching of separate mathematical disciplines and selected topics in English (references may be found in [3]).

Mathematical Education as Component of Professional Competence of IT Specialists

Knowledge of the basic theoretical foundations and possession of the skills of applying the theory of mathematics is important for the professional development of future specialists in all technical specialties. Education in the field of information technology should be problem-oriented and provide broad training for comprehensively trained professionals prepared for continuous improvement of their skills. This can be achieved by the fundamentalization of the educational process and the use of STEM technologies. Most students of IT specialties require a fairly deep mathematical

education. But the intensity and depth required differ for students who are research-oriented and those industry-oriented.

On that account, the level of mathematical training of most of first-year students of National Aviation University (NAU) is average. The level of mathematical training of students of the Faculty of Computer Science and Cybernetics of Taras Shevchenko National University of Kyiv (KNU) in general is notably higher.

However, regardless of the level of training of first-year students most students at National Aviation University require a sufficiently deep mathematical background. Therefore, the curricula of these specialties contain various collections of mathematical disciplines. This is especially true for IT professionals.

As an example we consider three different curricula for IT specialists of specialties "Computer Science", "Computer Engineering" and "Software Engineering". These curricula include the following collections of mathematical disciplines: "Higher Mathematics", "Theory of Probability, Probabilistic Processes and Mathematical Statistics", "Discrete Mathematics" and "Numerical Methods"; "Higher Mathematics", "Discrete Mathematics" and "Theory of Probability and Mathematical Statistics"; "Mathematical Analysis", "Linear Algebra and Analytic Geometry", "Discrete Mathematics" and "Theory of Probability and Mathematical Statistics".

The basic course (Course training program) of Mathematical Analysis for IT specialists should include Calculus I (single variable differential and integral calculus) and Calculus II (multivariable differential calculus, differential equations, series (numerical series and power series)). Additionally this course may include complex numbers, multivariable integral calculus, Fourier series and Fourier integral, complex analysis and operational calculus ("Special Sections of Mathematics").

The basic course (Course training program) of Linear Algebra and Analytic Geometry for IT specialists should include elements of linear algebra (determinants, matrices and systems of linear algebraic equations), elements of vector algebra (linear operations with vectors; dot, cross and triple products of vectors), straight line on a plane, plane and a straight line in space (standard equations and the simplest problems), curves and surfaces of the second order (standard equations). Additionally this course may include linear spaces, basis of linear space, vectors coordinates, transformation of coordinates, linear operators, matrix of linear operator, eigenvalues and eigenvectors of linear

operator, reduction of matrix of linear operator to diagonal form.

The basic course (Course training program) of Theory of Probability and Mathematical Statistics for IT specialists should include random events, discrete random variables, continuous random variables, law of large numbers, limit theorems, systems of random variables and elements of mathematical statistics.

The basic course (Course training program) of Numerical Methods for IT Specialists should include approximate calculations, iteration methods, numerical methods of linear algebra, approximation of functions by polynomials, numerical calculation of definite integrals and numerical integration of differential equations.

The core courses (Course training program) of Discrete Mathematics for different IT professionals are different. However, they should always include sets, operations with sets, mappings of sets, relations, combinatorics, graphs, elements of mathematical logics, Boolean functions and algebraic structures.

In addition, there are quite a number of problems related to the teaching of foreign students to differential and integral calculus, since this section is difficult enough to perceive, especially in technical colleges. In many countries, in addition to the known methods of change of variable and integration by parts, a third method is also studied: integration by the formula, which consists in students substituting their parameter values to the formulas given in the textbook and immediately getting the result. Most students have mastered this method best, which is why they have considerable difficulty learning the first two methods. The definite integral is introduced in schools as an increment of antiderivative. This complicates the perception of the definite integral as the limit of the integral sums.

In many textbooks, which are intended for technical universities and popular among students, the material is presented in the following order: derivative, definite integral and its properties, the basic formula of integral calculus, the applications of a definite integral, integration technique. This gives the illusion that the latter question is less important.

The problems associated with the teaching and training of foreign students at National Aviation University and Taras Shevchenko National University of Kyiv are very similar. A deeper study of mathematical disciplines at KNU requires foreign students to be more concentrated, choose more optimal ways of studying, and search for new teaching technologies.

Issues of formation of professional competence of future IT specialists in the teaching of mathematics were considered in [4 – 6].

About Teaching to Mathematical Disciplines in English

As English is one of the official languages of the International Civil Aviation Organization (ICAO), it is very important for future aviation professionals to be able to obtain a professional education in English. Moreover, English is now recognized as a basic life skill for the 21st century, like using a computer, rather than as a specialist accomplishment. It provides people with the ability to explore and navigate wider ranges of information and viewpoints than if they just have their home languages [1]. This is especially true for IT professionals.

Education in English in universities is a trend now. It is implemented for at least part of the disciplines in many universities in Ukraine. Some universities are preparing for the implementation of education in English. As example, the preparation of the Department of Higher Mathematics of the DSEA for teaching mathematical disciplines in English is analyzed in [5].

The students' language background received at school is also important for the implementation of education in English. Sufficient language competence of students, taking into account the specifics of mathematical terminology, is important for university teachers. It should be noted that the assessment of students' and teachers' communicative competence is a significant difficulty. Methods and results to assess the level of student' skills (future primary school teachers) of a foreign language and their communication skills, using algorithms to process the classification and select the best option from a variety of possible, are analyzed in [6].

Education in English is quite prestigious and popular among both foreign and Ukrainian students of National Aviation University, as it opens up wide prospects for further employment in international airlines, for work in the field of computer technology, for the use of advanced scientific developments, especially within the framework of Ukraine's integration into the world community. Since 1999 for the purpose of training highly qualified competitive specialists who would be fluent both in professional and informal English on separate specialties the teaching in English was introduced in the framework of the program "Higher Education in Foreign Languages". Within this program for twenty years for separate specialties all teaching was conducted in English.

The NAU program "Higher Education in Foreign Languages" provides an opportunity for international students to shorten their studies at the university by completing language training at the preparatory department. That is why the number of the first-year students studying in English is constantly growing.

At present, at Taras Shevchenko National University of Kyiv the implementation of education in English is at the preparatory stage. There are separate specialties in IT technology where training is conducted in English. The introduction of teaching in English is associated with the concept of academic mobility. Students of the Faculty of Computer Science and Cybernetics practice in leading IT firms, for example, Samsung, Google, Microsoft. After graduation, they work in the same companies, or leading Ukrainian IT firms, where English is the working language.

Analysis of the contingent of foreign students studying at NAU shows that they are representatives of different education systems, which often differ from each other. Level of cognitive activity that some foreign students have acquired in their homeland, in many respects does not correspond to the level of knowledge of Ukrainian students. Therefore, when teaching mathematics for such students, it is necessary to pay attention to the peculiarities of teaching mathematics in secondary schools of the respective countries. Teacher has to keep in mind that English is not a native language for the students; take into account that secondary school education was conducted in the native language; foreign students are native speakers of languages that are characterized by either different from our usual direction of writing or hieroglyphics (references may be found in [2–4]).

In many textbooks, intended for technical universities and popular among students, the material is presented in the following order: derivative, definite integral and its properties, the basic formula of integral calculus, the applications of a definite integral, integration technique. This gives the illusion that the latter question is less important. There are issues with solving applied problems. For students of technical specialties particular attention should be paid to the problems with technical content. However, in secondary school the main focus was on the application of the integral to solving economic problems.

Significant problem encountered in teaching the discipline "Linear Algebra and Analytic Geometry" and the corresponding sections of the discipline "Higher Mathematics" are the poor level of school

background in geometry. Particularly difficult for students to study are problems related to curves and second-order surfaces. However, it should be noted that foreign students are better trained in combinatorics, basic theory of probability, and have studied approximate calculations more. As a rule, their perception of more abstract issues is much lower.

Some terms in Ukrainian and English literature are denoted differently: for example, mathematical expectation and variance. This fact must also be taken into account. Also, many differences in the notation of trigonometric functions exist.

On experience of applying information technologies in English-speaking academic groups

In the process of teaching English-speaking students, especially in IT-specialties, the problem of using computer-oriented technologies in the educational process is especially relevant. Implementation of information technology in the study of all disciplines opens wide prospects for deepening the theoretical knowledge base, strengthening the applied orientation of learning, the disclosure of creative potential of students. This is especially true for IT students according to their inclinations, requests and abilities. The active role of information technology in education is due to the fact that compared to traditional manuals, computer-based learning tools provide new opportunities, as well as allow the implementation of modern pedagogical learning technologies at a higher level, stimulate the development of didactics and teaching methods.

There are a fairly large number of problems associated with the teaching and mastering by students of analytical geometry, geometric applications of differential and integral calculus and the theory of differential equations, since these sections are quite difficult to understand, especially in technical universities. In this case, additional tasks arise of analytically solving various equations and systems of equations, calculating derivatives and integrals, operations with matrices, etc. As a rule, solving these auxiliary problems is very difficult for many students. In organizing the learning process in solving such problems, information technology has provided significant assistance. This is due to the fact that the computer allows you to make quick calculations, organize mathematical experiments, build mathematical models, etc.

An important role in the educational process is played by clarity, thanks to which the researched material is better assimilated. Therefore, we consider

it appropriate to use multimedia tools. On slides, for example, it is expedient to show English terms with translation, to show features of designation of various mathematical characteristics in English and Ukrainian literature. Also it can be very useful for all students to receive at least part of lectures in a multimedia classroom with usage of various technical tools to visualize the geometric objects considered.

Problem of using computer-oriented technologies in the educational process is especially relevant in the process of teaching students of English-speaking groups, especially in IT specialties.

It should also be noted that students studying in all IT specialties of knowledge better perceive the supporting materials in the form of flowcharts of appropriate algorithms, and students studying in technical specialties, better perceive the supporting materials in the form of tables.

In our opinion, helping students to master techniques for solving various problems using computer algebra systems (for example: Mathematica, MATLAB or MathCAD) is very important. System Mathematica provides great computational capabilities, allows you to solve many problems of linear algebra (including the reduction of quadratic forms to canonical form), mathematical analysis (differentiation, integration, series expansion, Fourier transforms, integral transforms, differential operators), problems of probability theory and mathematical statistics, discrete mathematics, graph theory. However, MATLAB and MathCAD are more popular among students.

An interesting feature of many students of English-speaking groups is a higher psychological readiness than other students for using the symbolic core of computer algebra systems (CAS). Perhaps this philosophical peculiarity of these students is connected both with the peculiarities of their preparation in high school, and with their multilingualism. In general, it is natural to assume that for graduates of technical universities the most successful for the full solution of various applied mathematical problems is the skill of combining analytical methods, using the symbolic core of computer algebra systems and numerical methods.

It should also be noted that foreign students are more willing to use computer algebra systems than Ukrainian students and have a certain level of skills in applying these systems. Therefore, in order to at least partially compensate for the shortcomings of the general mathematical training of these students, we recommend them to actively use computer algebra systems [2, 6 – 8].

.Significant difficulties for foreign (as well as many Ukrainian) students, even with good mathematical training, arise when studying Fourier series, Fourier integral and Fourier-transform. It is especially difficult for students to solve problems on the construction of frequency response, because they do not distinguish well between different cases of development of functions in the series and Fourier integral.

Note that for future professionals it is very important to be able to apply both analytical and numerical methods and to distinguish situations of their use. Methodical recommendations for the application of Fourier-transform and z-transform is considered in [7, 8]. Recommendations for the application of the symbolic core of the computer system MATHCAD in solving problems on the expansion of functions in the Fourier series, on the representation of functions by the Fourier integral and the implementation of direct and inverse Fourier transform is given in [8].

Conclusion

The implementation of information technology in the study of all subjects opens wide prospects for deepening the theoretical knowledge base, strengthening the applied orientation of learning, opening of creative potential of students. Especially this implementation is desirable for education of students studying in IT specialties.

It is important to pay enough attention to bringing to students the peculiarities of the use of terminology in the process of constructing mathematical models and in solving applied text problems and providing methods for the application of CAS.

The experience of NAU and KNU in the implementation of training in English confirms the need for the implementation of such projects. The industry orientation of training at NAU and the scientific orientation at KNU are based on the same curricula, differing only in their content. An important point is the assessment of the English competence of graduates of both universities. The following studies will be devoted to these questions.

The availability of a full learning cycle in English at the university, together with the harmonization of the content of credits in the curricula, will facilitate the university's future entry into the European Higher Education Area within the scope of the Bologna Process. Education in English is prestigious and desirable for other Ukrainian universities; it is especially useful for attracting foreign students and promotes academic mobility.

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