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Mathcad Application to Math Problem Solving for the Students of the Faculty of Civil Engineering of Riga Technical University

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***Abstract* – Including Information and Communication Technologies (ICT) teaching technologies in the higher education we have to be ready to accept the new methods and modules of teaching, which include multidimensional teaching object and lecture forms, which are supported by the latest technological developments. Program development of mathematics consists of the analysis of the present program extent and content and the understanding of the achievable competences. The programs of mathematics and the didactics have to be changed based on ICT (putting greater emphasis on the application of mathematics by constructing the teaching materials based on the modern technologies and the availability of the Internet).**

***Keywords* – Mathcad, math program development, teaching mathematics.**

I. Introduction

Lately the discussions on the teaching of mathematics at schools and universities have been emerging. A positive attitude towards mathematics motivates students to learn more, which in turn provides better success in mathematics. This principle also works the other way around, good progress in mathematics combined with a positive experience in the subject results in a positive attitude towards mathematics [7]. Students often start their studies with a positive attitude towards mathematics, but later it becomes negative. This could be due to the pressure on students to deal with complex tasks that are not in accordance with their interests, as well as monotonous performance by lecturers [8].

As pointed out by E.Ģingulis [5, 6], the main difficulty in learning math is caused not by the lack of ability, but by the layering of the previous negative experiences that causes dislike, tunes to likely failure, causing stressful conditions in which a person is not capable of showing his/her best possible performance.

Effective teaching of mathematics envisages the use of diverse teaching methods. To operate effectively, mathematics teachers need a thorough knowledge of the subject, understanding of how to teach it and flexible application of the teaching methods to suit the needs of all students. In addition to concerns about the increasing age of mathematics teachers and unequal gender balance in some countries, a major challenge is the improvement of mathematics teachers' competencies.

Nowadays, the main goal of teaching mathematics at universities is to educate and train students for the practical use of the acquired subject. That is why the learning process should be solid, purposefully designed and meet the demands of today's economic and information globalization.

Therefore, mathematics study programs and didactics at universities should be developed based on ICT (paying more attention to application of mathematics, including the use of ICT), designing modern technology-based learning materials and ensuring their access via the Internet. When incorporating online learning technology into higher education, it is essential to be ready to accept new learning models and techniques, which include multi-dimensional object learning and teaching forms supported by the latest technology solutions.

II. Modernization of the Education System

In response to the rapid changes, Latvian higher education institutions, including RTU, are developing curriculum content, improving quality of the courses, ensuring the modernization of the education system, significantly improving the foundations of acquisition of modern knowledge and skills and educationg and training students for independent work life.

A lot of attention is dedicated to students' self-directed learning, student participation and active involvement in curriculum planning, acquisition of knowledge and skills and their own performance evaluation.

University management has realized that a great help in self-directed learning is e-learning.

E-learning is what we might call a combination of training and internet [3]. It is not the mere download of the material – students are given an opportunity to access their grades, materials, as well as are given a platform for online discussion with their fellow students. E-learning makes it possible to track the progress of each student, his/her abilities, and requirements and to deliver only the information he/she wants. In fact, a combined training method is applied to the learning process – classroom activities are combined with the work in e-learning environment. E-learning format will allow students to better plan their time – to learn at their own convenient time and pace, and virtually connect with other students and faculty.

Advantages of e-learning:

- documents are available at any time and place that has the Internet access;

- heterogeneous data formats can be used creating global data blocks;
- the use of technology is an incentive to learn, because it offers a variety of resources to acquire academic knowledge; working while studying, a student can successfully resolve conflicts between space and time usage;
- individual learning space.
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Problems of e-learning:

- the role of individual differences in acquiring special skills and training material in online learning environment;
- how to provide quality distance learning in e -learning environment, to develop efficient networking, to develop new format guidelines;
- students do not know the rules of e-environment learning: how to learn, discuss and work with the curriculum and work with the teacher.

Changes in the practical training of engineers are necessary because the engineer's work combines complex technical and organizational combinations and engineering projects that will be more closely linked to social and political considerations, with new business models. Therefore, coaching changes should include a number of important criteria:

• sustainability – engineering projects and activities require a systematic and integrated approach in order to reduce the social and environmental impact of engineering;

• complexity – increasing the volume of information, the complexity of projects and systems, unexpected phenomena may appear,

• cooperation – improving the results of all the new forms of business, by learning to cooperate and not to compete;

• risk management – to be aware that complex projects can cause unforeseen harm to the health, environment, safety and other dimensions, thus requiring critical thinking and knowledge in these areas;

• ability to see the opportunities – modern complex projects require talented engineers capable of effective troubleshooting and meeting customers' expectations.

III. ATHCAD USE IN MATH

Working as a mathematics lecturer at the Faculty of Civil Engineering, the issue of acquired mathematical knowledge application in specialist's professional activities is currently being brought up in my work. The answers to the following questions are being sought: what needs to be taught and how to ensure that the acquired mathematical knowledge is of use in the professional working environment.

Mathematics teacher must adopt a new technology-based training system, allowing students to apply their mathematical knowledge already during the study process [2], [10].

Since the late 1980s, the integrated automation system for mathematical calculations (Mathcad) has gained widespread popularity. It was developed by a firm Mathcad Soft (the USA). Within the system, mathematical solutions are made using traditional mathematical formulas and symbols.

Popularity of the program is supported by the fact that over the past few years several versions of the program appeared in the market. The program works in Windows, it is relatively easy to use, as the form of mathematical expressions matches the usual style used by humans.

Mathcad system [9], similarly to other applications, is continuously developing and improving, thus resulting in a wide range of versions. Using Mathcad one can get results for both simple tasks and complex ones, including:

• to perform arithmetic operations using built-in functions and mathematical operators;

• to define the variables and functions;

• to evaluate the shift of function and expression values in the argument change area;

• to quickly construct one- and two-argument function graphs;

• to conduct operations with matrices;

• to perform function differentiation;

• to calculate the sums and integrals;

• to solve equations and systems of equations numerically.

Tasks [1] can be solved both numerically and analytically by a special symbol method. The data and results can also be displayed in a graphical form.

Mathcad main selection screen and eight buttons on the screen for entering various symbols, functions and graphs (Fig. 1, Fig. 2):

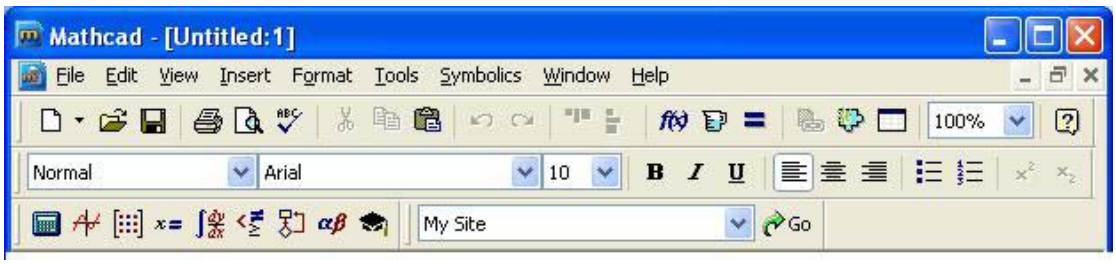
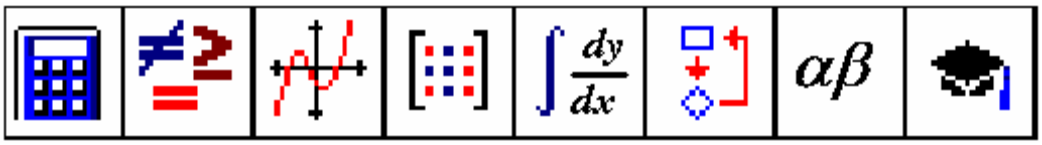


Fig. 1. Mathcad main selection screen.



1 2 3 4 5 6 7 8

1 – arithmetic operators, 2 – relationships operators, 3 – graphic designer; 4 – matrix operators,
5 – mathematical functions, 6 – programming commands, 7 – Greek letters, 8 – symbolic operators

Fig. 2. Buttons on the screen for entering various symbols, functions and graphs.

The data and results can also be displayed in a graphical form.

If a graph in polar coordinates is needed, we choose **Polar Plot** (Fig. 3) from the graphic drawing tools.

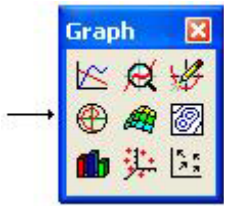


Fig. 3. Graphic drawing tools.

The data from other files can be inserted into the program and sent back.

The computer cannot solve the task that is not understood by the solver and cannot formulate its resolution algorithm. However, even if such an algorithm is formulated, it must be entered into the system in a comprehensible form.

Working with matrices (Fig. 4):

1. Matrix can be entered with the keyboard by pressing the ***Ctrl*** key and the letter ***M*** or using a matrix tool by clicking on the matrix vector buttons.

2. ***Insert Matrix*** command window will open, the numbers of matrix rows and columns need to be entered and then ***OK*** or ***Insert*** needs to be pressed.

3. Fill the empty place-holders (black squares) with the values. Moving from one value to another, use the ***Tab*** key.

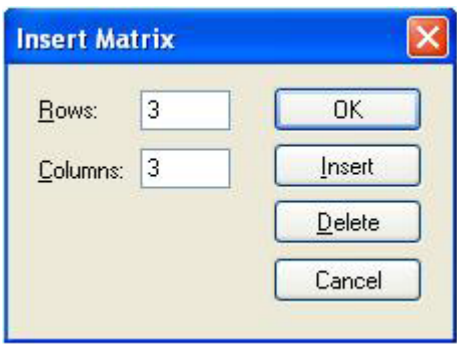


Fig. 4. Matrix tools.

Educators – constructivists give students an opportunity to try out their new ideas, evaluate information, and find new solutions in different situations. The teaching context is also of great importance, it must inspire creative thinking and critical approach [4].

Technology alone does not guarantee educational success. It only becomes valuable if students and teachers can benefit from its use.

On February 4, 2003, during the opening of Learntec Forum in Karlsruhe the Commissioner Mrs. Reding spoke about mixed learning as the future of e-learning. Modern e-learning solutions recognize the importance of learning as a social process and offer opportunities for collaboration with other students, the use of interactive learning content, provides an opportunity for teachers and trainers to manage the process. Teachers and trainers once again play a key role, they use "mixed" approach, combining both virtual and traditional, face-to-face, meetings with their students. It is an approach, in which they are no longer considered to be pre-determined e-learning content consumers, but also its editors, authors and contributors to teacher-student interaction and shared responsibility recognition in the learning process.

Using ICT in mathematics learning process will significantly improve the quality of higher education and the level of expertise of young specialists in the labor market.

IV. Conclusions

Experience shows that the skills acquired in solving specific mathematical problems (using the analytical methods as well as using the package Mathcad) enable students to better understand the math course, as well as its applied use in their further education.

To include ICT technologies (online) in the learning process at higher education institutions, it is necessary to adopt new models and methods of training, which include a multi-dimensional shape of the objects and forms of training lectures, which are supported by the latest technology solutions.

Using the capabilities of the implementation of ICT in teaching mathematics program, we not only facilitate the work of teachers making learning more interesting and effective, but also significantly improve the quality of higher education and the level of training of new employees in the labour market.

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