SOFTWARE PACKAGE MATHLAB IN LINEAR ALGEBRA TEACHING

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Introductions. Using of mathematics software packages is one of indicators of the professional learning level of university graduates in information computer technologies (ICT). The problems of linear algebra are easy to algorithmize. To increase the efficiency of students' professional competencies formation, it makes sense to talk about algorithms in the form they would be performed by a computer. The ICT use in linear algebra teaching is becoming relevant. The main types of educational software are electronic textbooks, mathematics software packages and monitoring software. However, there is no educational virtual environment for practical tasks. Mathematics software packages Mathematica, Maple, MathCAD, Matlab are used at practical classes. They will automate arithmetic calculations and enable students to focus on the essence of method. In some mathematical packages, including Matlab, tools for the distance development of a Web application focused on complex calculations were developed.

Aim. The purpose of paper is to present the capabilities of the Matlab package in linear algebra teaching using practical tasks.

Materials and methods. Typical tasks of linear algebra are: finding a solution of linear equation systems, calculating the values of determinants and the matrix rank, finding a linear operator matrix, studying the roots of polynomials in one variable (Robert A Beezer, 2006). Linear algebra tasks are easy to algorithmize, but their implementation in the mathematical package Matlab is possible.

The system of linear equations is given:

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n = c_1, \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n = c_2, \\ \cdots \\ a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n = c_n. \end{cases}$$

$$\mathrm{A} = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix} - \text{the matrix of coefficients;}$$

$$C = \begin{pmatrix} c_1 \\ \cdots \\ c_n \end{pmatrix} - \text{column vector of free members;}$$

$$X = \begin{pmatrix} x_1 \\ \cdots \\ x_n \end{pmatrix} - \text{column vector of unknowns;}$$

Given $|\mathrm{A}| \neq 0$, the system has a single solution.

Example:

$$\mathrm{A} = \begin{pmatrix} -3 & 5 & 13 \\ 11 & -5 & 7 \\ 2 & -1 & -6 \end{pmatrix}, \quad \mathrm{C} = \begin{pmatrix} 46 \\ 22 \\ -18 \end{pmatrix}.$$

Let's consider three ways to solve a system of linear equations using Matlab.

Table 1

Ways to solve a system of linear equations using Matlab

1 way. Using the built-in function	
Function linsolve(A,C)	>> X=linsolve(A,C) X = 1.0000 1.0000 1.0000
2 way. Using matrix division right to left	
The matrix determinant A is calculated Vector X.	>>det(A) >>X=A\B X = 1.0000 1.0000 1.0000

3 way. Gauss method	
Construct the extended system of linear algebraic equations matrix using horizontal concatenation.	>>P = [A, C] –3 5 13 46 11 – 5 7 22 2 – 1 – 6 – 18
Reduce the matrix P to a triangular form, using the built-in rref (P) function.	>>P = rref(C) P = 1.0000 0.0000 0.0000 1.0000 0.0000 1.0000 0.0000 1.0000 0.0000 0.0000 1.0000 1.0000
Assign the value of the last column of the matrix P to the vector X.	>>X = P(: , 4) X = 1.0000 1.0000 1.0000

If the course of the solution is not important, then the command "a\c" is used. To solve the system of linear equations by the Cramer method, it is necessary: to set the main matrix of coefficients for unknowns; set auxiliary matrices; calculate unknown systems of equations by dividing the determinant of the corresponding auxiliary matrix by the determinant of the main matrix.

To solve linear systems or nonlinear equations, Matlab has a special solve function. It is necessary: to determine symbolic variables, calculate unknowns by the formula [x1, x2, ...] = solve ('equation1', 'equation2', ...), derive the found solution with a given accuracy using the vpa function (variable, number of characters).

The graphical method can be applied to systems of dimension 2 or 3. It is necessary: to set symbolic variables, a function, design a function graph, add grid lines to the graph, use the graphic "magnifier" to scale the graph to achieve the required accuracy in determining the roots of the equation, the abscissas of the intersection points of the graph of the function are the roots of the equation.

There is the development of educational courses with automatic verification of homework, the integration of Matlab with modern and inexpensive equipment, a large number of learning video courses, documentation and many examples of code (Garrison, D and Vaughan, N., 2007). For example, Matlab Grader is a free teaching and learning environment based on Matlab. It designs the interactive learning courses, automatically evaluates students' work in real time, views the results of students completing individual tasks, compiles performance analysis for each student, establishes a weighted method for assessing of test tasks, uses libraries of reusable examples of courses and tasks, adapts courses for use outside the desktop for all users, integrates courses into the learning management system. To develop the interactive training courses, the teacher needs to create an account on www.mathworks.com. It should be linked to the university's license. After the registration, it becomes possible to develop a new course or use the available layouts and adapt them to the requirements. At a new learning course development, it is necessary:

- develop task's description.
- write the supporting decision.
- make a blank for students.
- write tests.
- check your decision.

It is necessary to add students to the course. Students are notified by email and receive a link to access the course. They should log in using their mathworks.com account password and email address. Matlab also has the ability to develop the interactive courses in the Live Editor. This application allows creating lectures, laboratory and practical works combined theoretical material, mathematical equations, program code and code execution results. Each block of the document can be launched independently and visualized code execution immediately after its execution.

Results and discussion. 274 first-year students of the Faculty of Physics, Mathematics and Informatics of Kherson State University took part in the

pedagogical experiment on the introduction of MATLAB in the course «Linear Algebra». During experiment the following tasks were solved: study on formation of mathematical competence; disclosure of methodical features of teaching the course «Linear Algebra» with the use of ICT; introduction of the MATLAB software environment in the process of learning linear algebra; assessment of the effective use of the environment in the discipline teaching process.

The formative stage of the experiment is characterized by the introduction of the MATLAB environment in the learning of elements of linear. Homogeneity and representativeness of experimental and control groups participated as respondents, regardless of their progress, interests, abilities etc. The homogeneity of the group was confirmed with the help of Student's t-test. The purpose of the formative experiment was to determine the effectiveness of MATLAB and to confirm or simplify the proposed hypothesis. The main task of the experiment was to evaluate the efficiency of student learning with the implementation of the experimental factor, i.e. the MATLAB environment, into the experimental group and without the introduction of the experimental factor in the control group. The experiment was conducted during study hours. In the experimental group students used the MATLAB environment during studying the elements of linear algebra in the general course «Linear Algebra», and students in the control group studied topics in linear algebra in the traditional mode of learning. Depending on the changes in the amount of hours, the distribution of practical and lecture classes may vary within the workload. Expected results of the experiment: as a result of using the MATLAB environment, the quality of learning the elements of linear algebra and the efficiency of learning increase.

At the final stage of the experiment, the results of the experimental research were processed and generalized, and conclusions were formulated. The impact of experimental learning was determined by the indicator of cognitive (knowledge) and activity (skill). Student's t-test was used to identify the differences in the levels of formation of mathematical competencies in linear algebra between the control and experimental groups.

Conclusions. Introducing the capabilities of the Matlab package into the learning process allows improving the students' professional level and forming their interest in learning.One of the significant advantages of the Matlab system is its integration into almost all areas of modern science and technology. Matlab is a global standard in higher education and research. The linear algebra teaching is based on the traditional presentation of the material. Matlab package application allows to increase the educational process efficiency and to form competencies necessary in future professional activities (Gilat, A., 2004).

Students are open to all kinds of technologies in Mathematics. This openness, together with the availability of high-tech tools, is changing the approach to linear algebra teaching.

REFERENCES

1. Technische Universiteit Eindhoven. An Introduction to Matlab and Mathcad Troy Siemers, Ph.D. Department of Mathematics and Computer Science Virginia Military Institute. https://www.tue.nl/
2. Bhushan, K. Matrix and Linear Algebra: Aided with MATLAB (3rd Edition). Prentice-Hall of India Pvt. Ltd, 2016.
3. Levy, P. Linear Algebra and Geometry using MATLAB. CreateSpace Independent Publishing Platform, 2016.
4. Gilat, A. MATLAB: An introduction with Applications. John Wiley & Sons, 2004.
5. Robert A Beezer. Linear Algebra .University of Puget Sound, 2006.
6. Matlab. https://www.mathworks.com/products/matlab.html
7. MATLAB for education. https://exponenta.ru/academy/lectors.html
8. MATLAB. https://www.mathworks.com/products/matlab/3