METHODICAL SYSTEMS OF LEARNING INTEGRAL EQUATIONS, USING MODERN COMPUTER MATHEMATICS SYSTEMS

Prof. Dr. Kalimbetov B., PhD. Sapakov D.
H.A.Yasawi International kazakh-turkish university, Kazakhstan
E-mail: bkalimbetov@mail.ru, sapakov1986@mail.ru

Abstract: *We consider methodological aspects of teaching integral equations in terms of introduction of information technologies in the higher education system, which gives an opportunity to students of mathematics to improve their mental and creative skills, develop their thinking and logic, and get the basics of professional competences.*
KEYWORDS**:** *INFORMATION TECHNOLOGY, LEARNING INTEGRAL EQUATIONS, SYSTEM OF COMPUTER MATHEMATICS MAPLE, BACHELOR OF MATHEMATICS.*

Introduction

Harmonious combination of fundamental principles of the traditional education and modern information technology offers great opportunities of qualitative reorganization of principles and methods of teaching classical mathematical disciplines. Analysis of traditional forms, methods and means of organization and carrying out of lessons determines necessity of development new approaches to learning that are characterized by qualitative changes of the education content and structure, and the introduction of information and communication technologies (ICT) in the educational process. To do this it is necessary to create new methodical systems of training future bachelors of the natural - scientific field, focused on the development of student's intellectual potential, on the formation of abilities independently to acquire knowledge and to carry out various types of research activities.

Today it is impossible to realize what was possible in the traditional university system. Classroom load is reduced, not only based on the increase of teaching efficiency, but also in connection with a reduction in the level of perception the information by the separately taken channel. Light version of universal higher education, overcoming language barriers, is extended synchronously with the information infrastructure. A deep special training or will be available to units of gifted students, or move to the post-graduate level.

Development of modern technologies in education should be carried out, taking the following principles into account (N.A. Usnovich, 2005; V.I. Bel'ko, V.V. Dainiak and O.M. Kondrat'eva, 2008):

- integrity of the technology, which represents the didactic system;
- reproducibility of technology in a particular pedagogical environment to achieve goals;
- prioritize of factors, affecting on the mechanisms of self-relevant pedagogical systems;
- adaptations of the learning process to the student's personality and its cognitive abilities;
- potential redundancy of educational information, which creates optimal conditions for the formation of generalized knowledge.

The significant contribution to the basis of development of the conceptual theory and methodology of information technologies use in teaching has been made by J.K. Babanskii, A.P. Yershov, A.A. Kuznetsov, M.P. Lapchik, N.V. Makarova, I.V. Robert and others.

Fundamental research of N.V. Talyzyna, V.M. Monakhov, A.A. Kuznetsov, A.V. Pankov, V.P. Kulikov, G.A. Kruchinina and others are devoted to the psycho-pedagogical problems of the design and use of information technologies in education.

By analyzing the content, features and capabilities of computer mathematical systems, we found that effective methodological approaches are implemented with adaptation of specially designed in Maple educational software products and textbooks, developed by university teachers in accordance with the thematic plans of taught disciplines, as well as views on the methodology of their teaching. Advent of computer mathematics systems (CMS) essentially and ambiguously impacts on the process of teaching mathematics in high schools, and has been a subject of many studies. For example, issues about use of CMS were studied by (V.P. Dyakonov, 2003; A.V. Matrosov, 2001; M.N. Kirsanov, 2007; O.V. Manturov, 2001; B.M. Manzon, 1997; A. Gray, 1991; Y.N. Burkhanova, 2013) and others.

Results and discusion

CMS Maple has already taken a strong position in higher education and it is an indispensable tool with which teachers can qualitatively change teaching methods and organize new forms of learning process, improve level of the studied material, better develop the individual characteristics of students, organize independent work.

Maple is an integrated system, i.e. it combines a powerful programming language, editor for preparation and editing of documents and programs, mathematically oriented user input language and programming language, multi-user interface with ability to work in a dialogue mode, the core of algorithms and rules for the conversion of mathematical expressions, program numerical and symbolic processors with a diagnostic system, the most powerful library of built-in and optional functions, packages of extension and application of the system and a huge, very easy to use help system. To all of these tools there is a complete access directly from the system.

The mathematical graphics of system allows us to obtain images of plane and space curves and surfaces, moreover, by all possible ways to modify them and combine. It is possible to build two- and three-dimensional graphics only by the selected expression (Smartplot option) without use of commands and reference of ranges for variables.

In the computing mode of Maple it is possible to interleave bursts of programs - one-liners, for which there is a fairly simple and intuitive command language. Moreover, the system has a large number of tools, devoted namely to the students, that largely explains the popularity of the system. Interface of Maple is convenient; there are push-button panels to input mathematical formulas.

Nowadays CMS Maple is widely known in universities of leading scientific research centers and companies. Hundreds of books are published, describing Maple and its numerous applications in research and for teaching natural science disciplines. Having an intuitive interface, easy work rules and broad functionality, the system has gained popularity among students, studied in the specialty "Mathematics" of natural - scientific direction.

The main concept of Maple that has been used as a basis more than 20 years ago is stored in the main despite the numerous upgrades and expansion. Maple is a system to solve mathematical problems. Now there are all reasons to bring it to use of the largest possible number of users. The last projects of Waterloo Maple Company allow us to suggest that in the near future its main efforts will be aimed at promoting the Maple as an interactive learning system. Even a special center dedicated to the popularization of Maple among students, is created.

Currently, CMS are gaining in popularity, and are increasingly used in training. A technique of using CMS Maple, MathCAD during the lectures is developed to demonstrate various graphs and

make mathematical calculations in technical universities (E.B. Klimenko, 1999). Theory and methods of using CMS Mathematica have been studied: for laboratory works during the learning of Higher Mathematics it has been studied in (S.A. D'yachenko, 2000), in the teaching of the Differential Geometry in (T.V. Kapustina, 2001), for Differential Equations in (R.M. Aslanov and A.S. Bezruchko, 2011), during the mathematical preparation of economic profile specialists in (E.A. Daher, 2004).

Development of a laboratory practice with CMS MathCAD in teaching mathematics students of pedagogical universities and methods of use of the CMS MathCAD software in the course "Numerical Methods" in the training of pedagogical high school students are considered in (I.B. Belenkova, 2004; U.V. Plyasunova, 2004).

Some authors (M.P. Lapchik, M.I. Ragulina and E.K. Henner, 2002) suggest to use CMS (MathCAD, Maple, Derive, Mathematica, MathLAB) for their theoretical development and formation of experience in these programs during the course "Information technology in Mathematics".

Recently, it is necessary to introduce these computer systems and programs into the learning process of integral equations that give an opportunity to students to develop their intellectual and creative abilities, develop thinking and logic, get basics of professional competences and determine the course of his future career. By using the CMS, future bachelors of mathematics have possibilities:

1) to compute and analyze all kinds of calculations, both numerical and analytical, or character;

2) to visualize analytical data, graphically process the results of experiments, build charts and bar graphs, build arbitrary images, using graphics primitives

3) to formalize and store electronic files, where it is possible to alternate text fragments, computing and graphics;

3) to create high-quality animations of graphics and, even analytical images;

4) to create a database and knowledge base;

5) to program, using the specific programming language of ultra-high-level for SCM, moreover, to program not only mathematical problems, but any combinations of actions, which are available in the system;

6) due to openness of CMS, user can input new features in the use, designing them on the base of the available system functions and by the method of conversion rules;

7) to create high quality educational software products in the environment, including computer textbooks and workshops with a branched structure, using hypertext.

For several years at K.A. Yasawi International kazakh-turkish university (Turkestan, Kazakhstan) research on introduction of ICT into the educational process is conducted, which includes the use of Maple CMS in the educational process of learning integral equations of the future bachelors - mathematics. As a result of the ICT introduction into the educational process database (Knowledge Bank) on integral equations is created, which includes computer textbooks, manuals, problem books, collections of tests, electronic dictionaries, reference books, encyclopedias, numeric data, computer training materials.

Let us consider some examples on Maple CMS application to study graphs of functions which are exact solutions of integral equations.

Example 1. Solve the Fredholm integral equation:

$$u(t) = t^3 + \int_0^1 (2+ts)u(s)ds.$$

Solution: Write an integral member of the equation in the following form:

$$\int_0^1 (2+ts)u(s)ds = 2\int_0^1 u(s)ds + t\int_0^1 su(s)ds.$$

Denote

$$Q_1 = \int_0^1 u(s)ds,\ Q_2 = \int_0^1 su(s)ds.$$

The original equation can be represented as the following algebraic equation:

$$u(t) = t^3 + 2Q_1 + Q_2 t.$$

Calculate Q_1 and Q_2:

$$Q_1 = \int_0^1 u(s)ds = \int_0^1 \left[s^3 + 2Q_1 + Q_2 s \right] ds =$$

$$= \left[\frac{1}{4}s^4 + 2Q_1 s + \frac{1}{2}Q_2 s^2 \right]\Big|_0^1 = \frac{1}{4} + 2Q_1 + \frac{1}{2}Q_2,$$

or

$$-Q_1 - \frac{1}{2}Q_2 = \frac{1}{4},$$

$$Q_2 = \int_0^1 su(s)ds = \int_0^1 s(s^3 + 2Q_1 + Q_2 s)ds =$$

$$= \left[\frac{1}{5}s^5 + Q_1 s^2 + \frac{1}{3}Q_2 s^3 \right]\Big|_0^1 = \frac{1}{5} + Q_1 + \frac{1}{3}Q_2,$$

or

$$-Q_1 - \frac{2}{3}Q_2 = \frac{1}{5}.$$

Consider the system of linear algebraic equations concerning to Q_1 and Q_2:

$$\begin{cases} -Q_1 - \frac{1}{2}Q_2 = \frac{1}{4}, \\ -Q_1 - \frac{2}{3}Q_2 = \frac{1}{5}. \end{cases}$$

Using the Cramer formula, we find Q_1 and Q_2:

$$Q_1 = \frac{D_1}{D}, \quad Q_2 = \frac{D_2}{D},$$

where

$$D = \begin{vmatrix} -1 & -\frac{1}{2} \\ -1 & -\frac{2}{3} \end{vmatrix} = \frac{1}{6} \neq 0,\ D_1 = \begin{vmatrix} \frac{1}{4} & -\frac{1}{2} \\ \frac{1}{5} & -\frac{2}{3} \end{vmatrix} = -\frac{1}{6} + \frac{1}{10} = -\frac{1}{15},$$

$$D_2 = \begin{vmatrix} -1 & \frac{1}{4} \\ -1 & \frac{1}{5} \end{vmatrix} = -\frac{1}{5} + \frac{1}{4} = \frac{1}{20}.$$

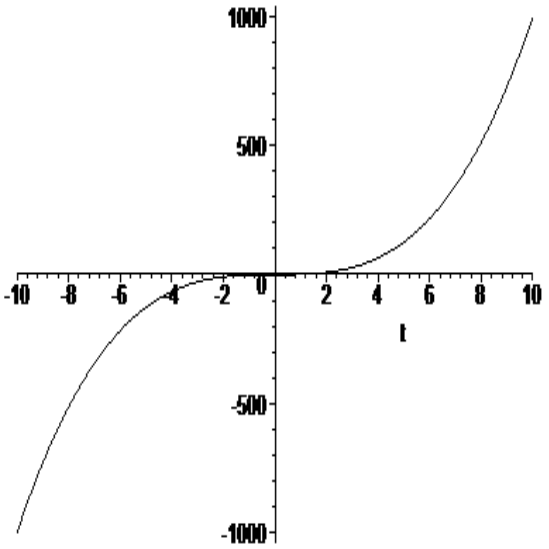
$$Q_1 = \frac{D_1}{D} = -\frac{2}{5}, \quad Q_2 = \frac{D_2}{D} = \frac{3}{10}.$$

Putting the values of Q_1 and Q_2 into the algebraic equation, we find the exact solution of the integral equation:

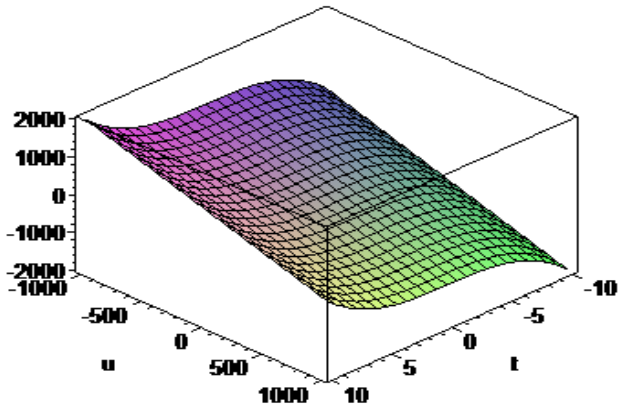
$$u(t) = t^3 + \frac{3}{10}t - \frac{4}{5}.$$

To study the behavior of the solution we will use the computer program system Maple.

```
> restart;
> u:=t->t^3+3*t/10-4/5:
> u(t):
> plot(u(t),t=-10..10,color=black);
```




```
> restart;
> f:=(t,u)->t^3-3*t/10-4/5-u:
> f(t,u):
> a:=-10..10;b:=-1000..1000:
> plot3d(f(t,u),t=a,u=b,axes=boxed);
```



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Conclusion

As a result, we can conclude that the mathematical computer systems can and should be used as a means of ICT in learning. The most effective application of computer mathematical systems for educational purposes can achieve when software of educational purposes and computerized textbooks, problem books, collections of tests, electronic dictionaries, reference books, encyclopedias, numeric data, computer training materials are developed in their environments.

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