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OPPORTUNITIES OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN TEACHING DIFFERENTIAL EQUATIONS

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Abstract:

This article provides suggestions and recommendations on the possibilities and use of computer mathematical applications in the teaching of differential equations.

Keywords: Differential equations, information and communication technologies, computer, mathematics, practical package, tool.

1.INTRODUCTION.

Despite the widespread discussion of the computerization of the educational process, the introduction of e-learning resources and practical packages due to the improvement of information and communication technologies (ICT), the scope of practical work in higher education, especially mathematics, attention is not at the level of demand. The results of our research and analysis of our observations showed that the use of ICT tools in the process of teaching mathematics in higher education institutions is not at the required level.

Therefore, one of the urgent issues is to improve the methodology of using ICT in the teaching of subjects in higher education, especially in the field of mathematics.

2.LITERATURE REVIEW.

The theory and methodology of the introduction of ICT in the educational process, the methodology of using Internet technologies in the educational process, the problems of distance learning have been researched by Uzbek scientists A.A. Abdukodirov, U.Sh. Begimkulov, R.H.Juraev, F.I. Zakirova, M.H.Lutfillaev, N.A.Muslimov, N.I.Taylakov, G.S.Ergasheva, scientists of the Commonwealth of Independent States A.V.Grinshkun, A.D.Ongarbaeva, D.V.Luchaninov, B.A.Kondratenko, J.K.Akkasynova, L.M.Ivkina, T.V.Yatsyuk, Yu.M.Kornienko, V.A.Brylyova, N.A.Goncharova], V.V.Gura, A.V.Danilkevich, V.V.Robert, G.K.Selevko, V.A.Trainev, S.G.Grigoriev, V.V.Grinshk, T.V.Kapustina.

From the analysis of the research work of the above-named scientists, it became clear that higher education institutions need to use information and communication technologies in the educational process, including the teaching of mathematics. There are various terms in the scientific and methodological work of these researchers, such as "Information and Communication Technologies", "Information Technology", "New Information Technologies", "Means of Informatization of Education". Researchers have given different interpretations to these concepts.

In this regard, according to the encyclopedia of P.F.Safarova, P. Kh. Juraev, information and communication technology is a new technical universal didactic tool for improving the knowledge, skills and abilities of students in a particular area. It broadens and deepens the learner's practical thinking and raises them to a higher level of knowledge, skills and competencies in a particular area. Information technology is a set of methods and processes used to collect, store, search and process information and distribute it. Information technology supplies include its components. They consist of software, technical, legal, information, organizational, textual and linguistic support [2].

According to I.V. Robert, information and communication technologies define the interaction with information for educational purposes and are "considered as a means of collecting, processing, applying and transmitting information for teaching by subjects of the educational process (teacher and student use") and provide a pedagogical and psychological impact aimed at developing the creative potential of the individual, the formation of a knowledge system of a particular subject area, the formation of a set of skills and competencies for the implementation of educational activities, including the study of laws in education [3].

According to G.K. Selevko, information technology is a set of systematic and massive methods of information processing in all types of human activity, created by applied informatics, using modern means of communication, printing, computing equipment and software. Information and communication technology tools are defined as "software and hardware devices that operate on the basis of computer technology and are used to support information dissemination, information exchange and collection operations" [4].

V.A. Traineev gives the following definition of information technology: "... a set of software and hardware for data collection, processing, storage and display in order to facilitate the operation of the user, increase its reliability and efficiency" [4].

In the textbook of B.J. Boltaev, M.R. Mahkamov, A.R.Azamatov, S.I.Rahmonkulova gives the following definition of information technology: "Methods and means of human search, collection, storage, processing and use of information." According to them, information technology consists of two factors: internal and external. Internal factors - methods, external factors - means [6].

In the textbook of S.G. Grigoriev and V.V. Grinshkun, the means of informatization of education is described as "... the use of computer hardware and software, as well as education to achieve the purposes of informatization." According to the authors, the most important modern means of information and communication technologies are "... a computer equipped with appropriate software and telecommunications equipment, along with the data placed on them" [7].

According to R. Hamdamov, U. Begimkulov, N. Taylakov, educational information tools are based on computer technology, communication tools, as well as interactive software products that model the tasks of the teacher in the organization of expression, transmission and collection of information, control and management of cognitive activity is a set of methods, forms and tools for creating pedagogical conditions [8].

Despite the differences in the above definitions, all authors emphasize that effective results can be achieved by applying these technologies to the education system.

We do not analyze the difference between all the definitions given in our study, i.e. we believe that ICTs are necessary to meet the needs of the learning process.

3.RESEARCH METHODOLOGY.

In the educational process, ICT provides a number of didactic opportunities. These include: the presence of immediate feedback between the user and the learning tool that determines the implementation of the interactive dialogue [9]; visualization of educational information about the studied object, process (visual image on the screen: object, its components or their models; process or its model; graphical interpretation of the studied process); data modeling and interpretation [3]; presentation of objects, their interactions, processes, events - in both real and virtual form (the presentation on the screen of a mathematical, descriptive, visual model corresponds to the original); archiving, storing, easily accessing, transmitting and reproducing large amounts of data [10]; automation of computational processes, efficiency of information retrieval activities, as well as processing of the results of the learning experience with the possibility of repeating the fragment or experiment itself; automation of information and methodological support processes, orderly management of educational activities in the organization and control of the results of assimilation [3].

B.S. Gershunsky [11] identified four areas of use of computer technology in the educational process: 1. Computer technology as an object of study; 2. Computer as a means of increasing the effectiveness of pedagogical activity; 3. Research activities in education as a means of increasing computer scientific efficiency; 4. Manager as an integral part of computer training and education.

A.S. Bezruchko considered that the dissertation "Methods of teaching the solution of differential levels of mathematics for future teachers, based on the use of information technology" serves as a tool to increase the effectiveness of computer pedagogical activity [1]. In our study, we also follow the opinion of this researcher. In this regard, B.S. Gershunsky notes that "... it is this computer that is considered such an integral part of the education system, which is able not only to make radical changes in understanding the category of "tool" in relation to the learning process, but all other components of the education system parts - goals, content, methods and organizational forms of education "[11].

Using the personal computer in the learning process changes the role of teaching aids in teaching. In our study, we consider the computer to be one of the components of the whole system of teaching aids, including traditional teaching aids that provide subject teaching in addition.

Informatization of education and the introduction of personal computers in the educational process changes the volume and content of educational material, changes curricula, which leads to changes in the structure and content of education in general.

Today, math teachers have a variety of software products that meet the learning needs at almost all stages of the learning process. Such software products include interactive learning systems, information learning environments, e-learning resources, didactic e-learning complexes, programs that assess and monitor student knowledge, application packages, simulators and e-reference books [10].

Because the science of mathematics is more complex than other sciences, learning poses some difficulties. Therefore, the use of ICT in the study of mathematics is an effective tool.

Initially, the first computers were developed to facilitate mathematical calculations (computers - electronic computers), so the use of computers in the teaching of mathematics began earlier than in other disciplines. In the field of fundamental mathematics and computer technology, a new direction called computer mathematics has emerged. V.P. Dyakonov describes this direction as "... a set of theoretical, algorithmic, hardware and software tools designed to effectively solve various types of mathematical problems on computers with a high degree of visualization

of all stages of calculations" [12]. Computer mathematics systems are often used as software tools in computer mathematics.

For this class of programs, researchers have different names: computer algebra systems, computer math systems, computer math sets, math systems, computer math practice packages [13]. In our study, we found it necessary to define a computer as a mathematical application package.

The era of creating computer mathematical application packages usually began in the early 60s. At that time it was possible to create computer systems capable of performing standard algebraic transformations: substituting and simplifying expressions, linear and nonlinear equations, their solution, performing operations on matrices, constructing function graphs and obtaining practical results. This has largely made it possible to study and analyze the analytical results.

The first practical packages of computer mathematics in the software market appeared in the 80s of the last century. Their development period dates back to the 90s. Currently, these practical packages provide high capabilities in performing mathematical calculations, conducting research and analyzing the results obtained [1].

These mathematical practice packages are constantly being updated, each subsequent version expands the capabilities of the previous one, but the basics do not change.

In his works, V.P.Dyakonov conditionally divides the mathematical applications of computers into four main classes [14]: digital computing systems; statistical computing systems; systems for special calculations; analytical computing systems (computer algebra).

Here is a brief overview of some of the possibilities of these mathematical practice packages.

GNU Octave is a system designed to perform mathematical calculations and experiments. With the help of the Octave application package it is possible to solve linear and nonlinear algebra problems, differential equations and linear and nonlinear problems of optimization, calculation of integrals and construction of function graphs [20].

Derive - a practical package is a universal mathematical practical package aimed at solving a wide range of mathematical and scientific-technical problems. The Derive application package is equipped with a library that significantly expands its capabilities [15].

Mathematica is one of the universal mathematical systems that allows you to solve a large number of problems without going into the complexity of the application package programming. With its help, digital and analytical calculations can be easily performed. One of the differences from the rest of the practical package is the two- and three-dimensional graphics, which are used to visualize curves and surfaces in three-dimensional space. The *Mathematica* environment includes a modern and high-level programming language, which is more convenient and has its own functional capabilities [1].

Maple is a high-performance computing system designed to perform complex computational projects using analytical and digital methods. The *Maple* application package has a digital algorithm for solving mathematical problems. It also has a library for calculating complex problems and a programming language. This solves specific problems by expanding its capabilities by allowing the user to create commands and programs independently. However, a good text editor, printable formulas, and stunning 2D and 3D graphics allow you to save the work done as a web page or as a standard text document [1].

MatLab is an effective application package for digital signal and image processing, management system design, natural sciences, finance and economics. Open Architecture creates competitive custom tools for research by facilitating the use of *MatLab* and related products [1]. Key features: fast and accurate digital algorithms; graphs for data analysis and presentation; interactive language and programming environment; user interface configuration tools; Interface and similarity of operators with modern languages such as C, C ++, Delphi and Java; support for data import from files and external devices, as well as access to databases and ancillary equipment using software; digital algorithms are fast, accurate and reliable.

MathCAD is a multi-functional interactive computing system with a practical package, which allows you to solve a large number of mathematical problems analytically and numerically without resorting to programming due to the built-in algorithms. *MathCAD* is a computational software for professors, researchers, students, technical engineers, physicists, and all professionals. In *MathCAD*, more than a hundred systems of linear and nonlinear equations with variables and constants, operations on matrices and vectors, algebraic calculations, Laplace, Fure integrals, arrays, simple differential equations, boundary conditions, special derivative differential equations, polynomials perform calculations on them. Using the MathCAD application package allows you to visually present the results of scientific work with graphs. The user will be able to depict two- and three-dimensional function graphs in the form of different colors, in a plane [16].

Maxima is a practical package designed to perform mathematical calculations. This application package has a large number of built-in commands and functions, as well as the ability to add additional functions and has its own language. It features a high-level programming language that demonstrates the ability to solve a variety of problems and link to a system to solve a number of tasks, such as creating separate modules [17].

Scilab is a practical package designed for engineering and scientific computational work. In terms of its capabilities, the Scilab package is comparable to the MathCAD math system, and in its interface it is similar to the MatLab package. Scilab has the ability to perform standard operations (e.g., arithmetic, comparison, etc.), allowing the user to expand by identifying data types. So they can use their libraries as if they were part of a built-in Scilab. Scilab is effective in constructing scales of two- and three-dimensional functions using a practical package [18].

Genius is a practical package with similar capabilities to math packages like MatLab and GNU Octave. Its standard functions are written in programming languages. The user must have programming language skills to use this application package. Genius provides an opportunity to demonstrate two- and three-dimensional function graphs using a practical package and analyze problems solved graphically [19].

Lectures were conducted using the mathematical practical packages of this computer. The results of their effectiveness are given below.

4.ANALYSIS AND RESULTS.

Experimental work is aimed at organizing lectures among students of pedagogical higher education institutions in the field of "Methods of teaching mathematics" in the department of "Differential Equations" with the help of information and communication technologies, in particular, mathematical applications of computers. 63 students were involved in the experimental work. The indicators of students who participated in the experimental work are given in Table 1.

General indicators of students at the end of the experiment

Table 1.

Groups	**Number of students**	**Assessments received by students in the experimental and control groups**			
		5 (excellent)	4 (good)	3 (satisfactory)	2 (unsatisfactory)
Experimental group	32	13	12	7	0
Control group	31	7	9	13	2

We perform a mathematical-statistical analysis of the overall average of the numerical data obtained from the table above using the Student-Fisher criterion. Using this criterion, the appropriate mean values for the samples $\overline{X} = \frac{1}{n}\sum_{i=1}^{4} n_i X_i$, the coefficients of scattering $D_n = \sum_{i=1}^{4} \frac{n_i (x_i - \overline{X})^2}{n-1}$, mean square deviations $\tau_n = \sqrt{D_n}$, the variance of the standard deviation $\delta_n = \frac{\tau_n}{\overline{X}}$, the formulas of reliable deviations of the estimate $\Delta_n = t_{kн} \cdot \frac{D_n}{\sqrt{n}}$, were used. According to the calculation, the average mastering rate of the experimental group was higher than that of the control group, i.e increased by 4.4%.

Also, in the organization of lectures in the section "Differential Equations" experimental work was carried out in two stages in order to determine the time of use of the computer in each lesson, using mathematical practical packages. In the first phase, lessons were organized using computer mathematical practice packages at different times in the classroom, and students 'knowledge was assessed. Based on the results of this analysis, we concluded that 15 minutes should be used in each lesson. In the second phase, when we surveyed 34 professors and teachers for this experimental work, the following times were identified (Table 2).

Table 2.

No	**Number of faculty**	**use of time**	**Percentage**
1.	21	15-20	**63,6 %**
2.	5	20-25	**15,2 %**
3.	4	25 -40	**12,1 %**
4.	3	40-60	**9,1 %**
Total	**33**		

6.6% of those who considered it appropriate to use 15-20 minutes during the lesson, 15.2% of those who considered it appropriate to use 20-25 minutes, 12.1% of those who considered it appropriate to use 25-40 minutes, 40% The number of those who said it was advisable to use at 60-minute intervals was 9.1%.

5.CONCLUSIONS AND SUGGESTIONS

Mathematical practical packages make it possible to analyze their results in terms of numerical solution of differential equations. By constructing two- and three-dimensional graphs of the results, it is possible to determine their solutions by graphically representing their solutions at different points. Therefore, it is expedient to use mathematical practical packages in higher education institutions to solve examples and problems related to the category of mathematics, in particular, differential equations, and to analyze their solutions.

In conclusion, we recommend the use of MathCAD and Maple mathematical practical packages in the organization of lectures on differential equations in higher education and in the analysis of examples and solutions to problems in the independent learning activities of students. These systems differ from other mathematical practical packages due to their convenient interface and simplicity of use operators.

Based on the results of the above experiments, we came to the conclusion that it is advisable to use 20 minutes of lectures in the section "Differential Equations" with the help of information and communication technologies.

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