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THE USE OF DIGITAL TECHNOLOGIES IN MATHEMATICS AND HIGHER MATHEMATICS CLASSES IN VOCATIONAL PRE-HIGHER EDUCATIONAL INSTITUTIONS

Introduction
The world is in the process of rapid informatization and digitalization of society in all its spheres. The way and pace of life of a modern person is not at all similar to the life activities of his predecessors, because he needs to be able to find, analyze, separate, transmit, receive and operate a large amount of information that he receives every day in various ways: through society, social networks and other Internet resources, which have recently become the main platform for communication and a source of receiving and transmitting information.

Training a citizen who can learn throughout life is impossible without digital skills. Media literacy is a key competence of the personality of our time. Therefore, the use of digital technologies in mathematics and higher mathematics classes will improve the digital competence of students, update the content of educational activities in classes, increase motivation to study, form an educational trajectory and own vision for solving certain professional tasks of future specialists in various fields.

The objective
To reveal the theoretical principles and practical possibilities of using digital technologies in classes, as a means of increasing the cognitive interest of students of vocational pre-higher educational institutions in the study of mathematical disciplines.

The subject and methods of research
In the process of research, methods of analysis of pedagogical, methodical literature and dissertation studies were used; a generalization of the results of domestic and foreign experience was carried out; comparison and systematization
of theoretical data; purposeful pedagogical observation of the process of using digital technologies in an institution of vocational pre-higher education.

Results

In the 21st century, humanity is witnessing numerous intensive scientific and technical transformations, although at the beginning of the 20th century, the development of science and technology was quite slow, and at the end of the century, it rapidly moved up. Today, we observe the informatization of society in all spheres of human activity: starting with enterprises for production purposes, leisure and education, ending with every home.

The digital space and its constant development cause changes in society itself. The modern world requires from an individual not only theoretical knowledge, but first of all skills and the ability to use them throughout life in constantly changing and non-standard or even problematic situations. Our modern society is moving from a society of knowledge to a society of competent citizens. That is why a necessary condition for the effective and efficient use of digital technologies in the educational process is students’ computer literacy which is inextricably linked with one of the key competencies of students – informational and digital [1, p. 9].

In higher educational institutions in different countries, students are offered disciplines aimed at forming general knowledge of informatics and computer technology; ability to use and create content using various digital tools; studying the regularity of acquiring knowledge, abilities and skills, forming beliefs based on electronic resources and using digital products. This is a response to the needs of society in the era of information and communication technologies. The main task of the disciplines “Mathematics” and “Higher Mathematics” is the formation of a scientific worldview, the development of mental abilities and personality qualities, the formation of professional competencies, the desire for self-education, self-improvement of students in various activities.

Today, the leading place in the teaching of the disciplines “Mathematics” and “Higher Mathematics” is occupied by traditional means such as a blackboard, chalk, a textbook and a notebook. But thanks to the use of digital technologies, the learning environment can be supplemented with video, sound, animation, etc. All this has a significant impact on the emotional sphere of the learner, contributing to an increase in cognitive activity, interest in the subject and learning in general, and intensification of educational activities.

“Mathematics” and “Higher mathematics” are disciplines in which the use of digital technologies can activate all types of educational activities: learning new material, preparing and checking homework, independent work, tests and control works, extracurricular work, creative work, etc.

Digital technologies allow the teacher to diversify the material at all stages of the lesson, increase the motivation of the students, their interest and contribute
to a stronger assimilation of knowledge. The use of a computer in mathematical classes makes it possible to reduce the time for studying the material due to the clarity and speed of work, to check the knowledge of students in an interactive mode, which increases the effectiveness of learning, helps to realize the full potential of the individual [2].

The use of modern digital technologies will allow:
- forming students' specific skills in using computer technology;
- using digital technologies in professional activity;
- obtaining information from various sources in a comprehensible form;
- working with various information;
- analyzing information analytically;
- expanding the knowledge of the peculiarities of information flows in one's field;
- applying knowledge of the basics of ergonomics and information security.

Advantages of using digital technologies in “Mathematics” and “Higher Mathematics” classes:
- saving time in classes due to a partial refusal to draw charts, diagrams and to take notes. Each student gets the opportunity after the lesson to receive a file with its recording, which can be viewed on a computer in any mode. At the same time, not only the illustrations and notes suggested by the teacher are available, but also the sequence of actions on the board is correctly reproduced;
- increasing the efficiency of the presentation of educational material. Combining an interactive whiteboard with a multimedia projector allows you to solve a number of tasks of improving the quality of the educational process. The multimedia projector displays a pre-selected background slide show on the surface of the interactive whiteboard. Acoustic systems create the necessary background sound in the audience, and the teacher is left to worry about the meaningful part of the material – writing or drawing on the interactive whiteboard (on any background);
- promotes the organization during group work (or group games) of skills that are fundamentally important for successful activities in many fields. Here you need flexible software and, preferably, an interactive whiteboard based on analog-resistive technology, so that students can write and draw with their fingers without thinking about how to share electronic markers among themselves;
helps in the organization of feedback and ensures non-linear presentation of educational material. Working with different audiences allows not only learning in an interactive mode (leaving behind the linearity of the presentation of material with feedback), but also immersiveness (the effect of the presence of different audiences) of the educational session. The use of multimedia, in particular, a multimedia presentation that has management tools that allow you to create a problem situation and maintain a dialog mode of operation. Studying new material allows the teacher to maintain a heuristic conversation and its high tempo;

allows you to immediately control the work of students and consolidate the educational material by conducting surveys and control works;

increases students' interest in learning.

Today, there are many different digital tools with which you can organize the educational process and which allow you to solve a rather large range of mathematical problems of different levels of complexity: GRAN1, DERIVE, EUREKA, Maple, Mathematika and others. These software tools are primarily intended for solving a wide class of problems by modelling the objects that appear in the condition of the problem.

They are equipped with a convenient interface; with their help you can implement many standard and special operations and functions, powerful graphics tools, proprietary programming languages, tools for preparing mathematical texts for printing are built into them, import of data into other software products (text and graphic editors, spreadsheets) and export of data from them for processing are provided.

The use of mathematical packages provides an opportunity to solve a wide range of problems:

- carrying out mathematical researches, which require analytical transformations and numerical calculations;
- development of algorithms for the implementation of numerical methods for solving problems, their analysis and use;
- mathematical modelling and computer experiment;
- analysis and processing of experimental data;
- visualization of research results, scientific and engineering graphics;
- creation of graphic and numerical reporting materials, etc.

One of the problems that arise in the process of solving problems with computer support is the choice of a software environment. Different computer mathematics systems can differ significantly in terms of functionality, interface, size, embedded programming language, etc.
A fairly popular system of computer mathematics is the highly powerful MathCAD mathematical package and the AdvancedGrapher software tool, which contribute to a better study of the following topics: Linear algebra; Vector algebra; Complex numbers; Differential calculus; Integral calculus.

The computer mathematical package MathCAD allows you to solve a wide variety of mathematical and engineering tasks, to carry out the modelling process, combining the power of modern calculations, tools of multidimensional graphic analysis with the simultaneous simplification of documents and design of calculation results.

To date, the MathCAD system remains the only integrated system in which the description of the solution to mathematical problems is provided using the usual mathematical formulas and signs. The results of the calculations have the same form. MathCAD includes several integrated components – a text editor for entering and editing text and formulas, a computing processor for performing calculations according to the entered formulas, a character processor, which is essentially an artificial intelligence system.

The user interface of the system is designed in such a way that a user who has elementary skills in working with Windows applications can immediately start working with the MathCAD system. Immediately after launch, the system is ready to create a document with the calculations required by the user.

Symbolic calculations allow you to perform analytical transformations (for example, differentiation, integration), as well as instantly obtain a variety of reference mathematical information. You can familiarize yourself with the purpose of the interface elements by placing the mouse cursor on the corresponding element and after delaying it for a few seconds, a window will immediately appear in which a brief explanation of the purpose of the specified interface element is given.

The MathCAD software package allows you to perform mathematical operations on complex numbers of any complexity, on matrices of any dimension, plot graphs of functions of two variables in space, calculate the limits of functions, and calculate the value of the definite and indefinite integral. All operations are performed almost instantly.

To perform mathematical operations, it is necessary to carefully set mathematical expressions, using, if possible, the Math menu bar and the Matrix menu bar.

It is advisable to use the MathCAD software package in practical classes in a computer classroom, or when working on the educational material independently [3].

Working with the MathCAD program does not exclude students' analytical actions, but serves as a means of controlling their actions. It is appropriate to use MathCAD as a “Handbook of Higher Mathematics”.
AdvancedGrapher is a powerful and easy-to-use program for constructing graphs and analyzing them. The environment supports the construction of graphs of functions of the form $Y(x)$, $X(y)$, in polar coordinates given by parametric equations, graphs of tables, implicit functions (equations) and inequalities, up to 30 graphs in one window. Computational capabilities: regression analysis, finding zeros and extrema of functions, intersection points of graphs with coordinate axes, finding derivatives, equations of tangents and normals, numerical integration.

AdvancedGrapher has powerful graph management tools. The program allows you to easily create, delete, duplicate graphs, change their properties and order in the list of graphs, build graphs of functions specified by several analytical expressions at different intervals.

Among educational trends, the use of mobile learning technology M-learning in the educational process deserves special attention. M-learning is spreading thanks to the development of mobile communication technology based on the use of the Internet, and in the future it can become a powerful means of increasing the success of learning at all stages of personality formation — from secondary education to higher education.

The situation observed today in the world undoubtedly proves the effectiveness of electronic (mobile) learning as a form of organization of the educational process, which can be implemented due to the use of ICT both in conditions of geographical distance between the student and the teacher, and directly in the educational institution for the formation of the student's independent activity in relation to assimilation of the study program by profession. It is because of such features as flexibility: mobility, convenience, equality, accessibility that students who are getting professional education study at a convenient time and in a convenient place. At the same time, the new role of the teacher in this process should be noted, which is expanding and updating, making him a mentor-consultant, a tutor who must coordinate the cognitive process, constantly improve the courses he teaches, increase creative activity and qualifications in accordance with novelty and innovations.

The benefits of mobile learning:
- the possibility of interactive cooperation between the teacher and the student in the dialog mode, which in some cases can approach dialogic interaction in traditional educational technologies;
- quick sending / receiving of educational materials in electronic form;
- operational access to Internet information resources;
- the ability to check and control knowledge remotely;
- the possibility of organizing laboratory workshops in virtual mode through the implementation of remote network access to real laboratory equipment;
‒ creation of “virtual groups” for operational interaction between students;
‒ the possibility of accumulating statistical data and, based on their analysis, managing the educational process;
‒ improving the quality of education and management;
‒ implementation of automated management of the quality of education;
‒ individualization of professional training by creating individual study schedules for individual students.

It is important to use the Learningapps.org service in the educational process.

The Learning Apps service (http://learningapps.org/) is a Web 2.0 service for supporting learning and teaching processes with the help of small interactive modules. These modules can be used directly as educational resources or for independent work and self-assessment of students [4, p. 24].

The Learning Apps resource differs from other services for creating didactic and interactive tasks by a wide variety of exercise templates and execution functions. An important auxiliary function of this site is the ability to view the tasks of other users as an example for developing your own interactive exercise. The task categories are arranged in the form of a visually convenient image grid, where you can also see the rating of the task category according to the number of times that template has been used by other users. By clicking on the image of the exercise category icon, we go into the mode of its direct development. After creating a certain task, we have the opportunity to publish it, download it or share it with others [5, p. 7].

This resource has a number of positive qualities, such as:
‒ free service;
‒ friendly interface;
‒ the possibility of exchanging interactive tasks;
‒ tasks can be created and edited online using various templates;
‒ many templates support work with images, sound and video;
‒ instant check of the correctness of the task performance;
‒ you can choose a category: “Mathematics”, “Computer science”, “Biology” and others, as well as “All categories” on the website;
‒ you can get a link to send by e-mail or a code to embed in a blog or site, and on a Wiki page [5, p. 9].

Using the capabilities of the Learning Apps.org service allows you to form educational competencies in students in a versatile and purposeful way and achieve planned results more effectively thanks to the inclusion of each subject of the educational process in cognitive, educational and creative activities.

KhanAcademy is one of the best international educational networks that allows students to study mathematics in a course-like environment.
The app contains online lessons, thousands of learning videos, quizzes, and a variety of math activities including calculus, trigonometry, statistics, arithmetic, beginning algebra, basic algebra, and more.

The best thing about KhanAcademy is that it is easy to use thanks to its simple interface and mastery system.

Key features:

- KhanAcademy is absolutely free;
- it provides a personalized learning panel that allows students to learn at their own pace;
- provides easy-to-understand information on a variety of college math topics;
- it can be used in both online and offline formats, that is, you can study mathematics without an Internet connection [6].

“XSection” is for the development of spatial thinking. “XSection” is working on the development of this skill. When we depict figures on paper, we transfer three-dimensional bodies into two-dimensional space, which is not always easy to imagine for a beginner who is just starting to study geometry. Hence the problems are with studying the subject.

The application contains a set of problems that cannot be solved without transferring a two-dimensional image of a polygon into a three-dimensional space. Also, the program will not allow you to create an “impossible” object, which is one of the most common learner’s mistakes.

A large number of tasks for the study of figures in space: prisms, cubes, parallelepipeds, pyramids, tetrahedron, diagonals of polygons, diagonal section, parallel and central projections, the method of internal projection, etc. Also, the program has a glossary with geometric terms; step-by-step instructions are also available [6].

Chegg Math Solver is a math solver and calculator developed by Chegg, Inc. It helps learners learn different types of mathematics, including pre-algebra, algebra, precalculus, calculus, and linear algebra.

This math problem solver stands out because it provides step-by-step solutions to math problems. This makes it easier for students of vocational pre-higher educational institutions to understand mathematics at the click of a button.

In addition, the mobile app allows users to scan and take pictures of math problems using the mobile device's camera. This feature will help save effort on entering complex math problems into the calculator. This digital resource is ideal for students struggling with math homework, preparing for math exams, and any student who wants to gain a deeper understanding of math problems.

Key features:

- provides a detailed explanation with substeps;
the input of the condition is carried out using the mathematical photo transformation function, which allows users to scan mathematical equations and take photos using their mobile devices;

- comes with a graphic calculator [6].

CheggMathSolver is a great learning resource for math because it includes step-by-step explanations. It also includes basic math problem explanations. Also, when studying the disciplines “Mathematics” and “Higher Mathematics”, you can use other digital tools that are effective and efficient for organizing consultative cooperation, providing recommendations, notifying of the results of academic achievements; provide the possibility of remote communication. In this way, feedback between the participants of the educational process is ensured. Since often the teacher needs other means to organize effective work in the class, digital tools that will be useful for the implementation of individual tasks will take into account the specifics of the subject and diversify the activity of students in the class.

One such tool is Kahoot, a free educational platform that allows you to conduct interactive classes and test students' knowledge through online testing. The Kahoot resource integrates the game into the educational process.

The digital platform Kahoot was developed in 2013 as a tool for quick creation of everything interactive: quizzes, polls and discussions, etc. The content created on the online service platform has a peculiar name “kahoot”, which denotes the created educational content. You can insert thematic videos and images into your own mini-games, and the process of creating a new exercise takes a few minutes. Thus, the time to prepare for the class is significantly reduced.

Another advantage of this service is the system of ready-made games developed by other users of the tool. That is, you can use your own tests or copy the tasks of other developers.

Kahoot online service is an effective tool for creating educational games, quizzes, discussions and surveys. Interactive educational games consist of a series of questions with multiple answers. Such game forms of work can be used in the educational process to test students' knowledge (formative assessment), as well as to prepare the audience for the final control of knowledge or to introduce an element of teamwork in the lesson. Kahoot allows you to easily and quickly test your knowledge of the topic and significantly reduces the time spent by the teacher on preparing for the lesson.

Participation in games created with the help of the service contributes to the organization of communication and cooperation in the team, increases the level of awareness in information and communication technologies, and stimulates the critical thinking of the target audience.

Kahoot is advisable to use for control work and tests, quick surveys, discussions and collective discussions, for the purpose of traditional or formative
assessment and reflection. To use Kahoot in educational activities, it is important to understand what task the teacher sets for the audience when creating a quiz, and, based on this, you need to make educational questions [1, p. 16-18].

The use of certain digital technologies is carried out at the choice of the teachers or the student.

Conclusions of the research

Currently, we can observe how Ukraine confidently moves in the direction of reforming the education system, which is based on the introduction of new approaches to students’ education, the creation of a modern and relevant educational space, the combination of traditional and innovative education, which implies the involvement of radically new means in this process. Most of them involve the use of digital technologies and are aimed at the formation of key personal competencies. The latest technologies globally affect the forms, approaches, methods and means of education, but their rapid development requires the simultaneous development of methods of their application in the conditions of the educational process of institutions of vocational pre-higher education.

With the help of digital technologies, in “Mathematics” and “Higher Mathematics” classes, the teacher has the opportunity to carry out the educational process on the basis of well-known principles of didactics, introducing interesting group or pair forms of work. It is undeniable that the use of gadgets strongly motivates and interests students to study, visualizes everyday activities with various interactive activities, which also contributes to the formation and development of creativity and critical thinking, which are priorities in the modern world. And only the hard work of teachers and students, the acquired experience will enable future specialists to effectively apply mathematical research methods based on information technologies in their future professional activities.

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Abstract

The article examines the peculiarities of the use of various digital technologies in mathematics and higher mathematics classes. The use of certain digital technologies is carried out according to different schemes in accordance with the needs of a specific lesson or topic, the level of mastery of various software products.

The author suggests using certain digital technologies when teaching mathematics, which will help to process information effectively, perform appropriate mathematical calculations, build graphs and diagrams, constantly maintain contact with students, form students' technical skills in solving mathematical problems, monitor the implementation of independent students' work, check the educational achievements of students.

It is emphasized on the advantages of using these or other software products which form cognitive interest in mathematical disciplines and contribute to the assimilation of the material, motivate and interest students in learning, contribute to the training of future specialists who are able to use information technologies in their future professional activities.

Keywords: Digital technologies, digital space, MathCAD computer math package, AdvancedGrapher graphing program, M-learning mobile learning technologies, LearningApps platform, KhanAcademy international educational network, XSection application, CheggMathSolver, Kahoot learning platform

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