

INTEGRATION OF DIGITAL TECHNOLOGIES INTO THE EDUCATIONAL PROCESS

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Abstract: this article discusses the integration of digital technologies into the educational process, innovative pedagogical technologies, and interactive methods. The implementation of certain methods, achievements and disadvantages, as well as examples of their integration into a rational learning process using digital technologies are considered. The introduction of digital technologies in the implementation of secondary vocational education programs is a necessary but insufficient condition for improving the quality of education. It is necessary to integrate digital technologies with traditional ones on the basis of mutual reinforcement or complementarity of their didactic capabilities. At the same time, each of the integrated technologies should have high didactic capabilities, since automation of inefficient processes only multiplies their inefficiency. A new stage of the digital revolution, which made digital technologies a publicly accessible and reliable means of solving various, including educational tasks, actualized the introduction of digital technologies into the educational process of vocational education. The article highlights the key principles that ensure the effective assimilation of information using information and communication technologies. The professional competencies necessary for teachers to work in a digital environment are also considered, including skills for integrating technologies into the educational process, creating digital content, organizing training and assessment using information and communication technologies. The mechanisms by which digital tools can contribute to the personification of learning and increase the motivation of students are described. The analysis of possible disadvantages and possibilities of digitization was studied.

Keywords: educational process, integration of digital technologies, method, information technology, individual approach, interactivity, digitalization, effect, development, knowledge, study.

Introduction. Digitalization of the educational process is a broad concept. It does not only include distance education or students using computers, as some believe. Digitalization implies the use of information technologies at all levels: not only educational, but also organizational (electronic diaries, chats with teachers). Technical innovations will affect different types of educational institutions: schools, colleges, universities, educational courses.

In [1] (Rashidov & Rasulov, 2020) the concepts of developing Higher Education in Uzbekistan until, investigating and using foreign experience for this purpose is discussed. Analysis of the organization of lectures, practical and independent training sessions in Higher Education Institutions of developed countries and their role in the effective organization of training sessions are provided. A number of recommendations for improving the quality of education based on international experience have been developed.

In [2] (Rasulov & Kurbonov, 2023) a statistical analysis to determine the effectiveness of students' independent learning which is based on digital learning technologies are provided. The results of pedagogical research were checked according to K. Pearson's criterion χ^2 . Mobile applications were developed in the disciplines of "Linear Algebra and Analytic Geometry" and "Numerical Methods", which were introduced into the training process of the experimental group in order to assess their effectiveness and compared with the results of the control group. The result of study showed that the mastery level of students is higher than 13%.

In [3] (Rasulov & Umarova, 2023) the opportunities of using information and communication technologies (ICTs) in the organization of distance learning at higher education institutions are discussed. This article covers the content and essence of the distance-adapted version of such methods as "Impulse-poster" and "Express-tests" on the example of some topics of "Discrete mathematics and mathematical logic". A statistical analysis of the effectiveness of innovative technologies proposed in the process of distance learning are discussed.

The paper [4] (Rasulova, 2020) deals with the theoretical foundations of the organization of independent creative works of students in the direction of Technology in Higher Education, and was issued the dynamics of their level of development based on the indicators of independent work of students and the skills of their independent work creativity.

Today, frequently used statistical tests are an important factor in assessing the effectiveness of teaching using software learning tools. For this purpose, in the paper [5] (Rasulova, 2023) the research hypotheses of participants of the control and experimental classes on the indices of the second, third and final stages with the indicators of the first stage, using the Pearson's criterion χ^2 , often used in statistical research. An experimental group's results proved to be 11% higher than the control groups.

The growing popularity of information technologies can easily be explained by the fact that they make life more convenient and simpler. Specifically in the educational process, the following advantages of information technology are highlighted:

- increasing the involvement, motivation and interest of students in the educational process;
- activation of independence and cognitive activity;
- visual and more entertaining presentation of material;

- access to large amounts of information, including outside the training course;
- lack of paperwork for teachers;
- feedback, simplification of communication between students, teachers and parents;
- use of distance technologies and the ability to study from anywhere in the world where there is an Internet connection;
- the emergence of many online training courses.

In addition, digital educational technologies help ensure an individual approach to each student, taking into account his characteristics and cognitive abilities.

Methods

Advanced learning technologies

Let us analyze the main technologies of digitalization of education that are used in the educational process.

STEAM

The name is an acronym made up of the first letters of the English words for science, technology, engineering, art and mathematics. Sometimes the arts are omitted, leaving only four disciplines, and then the acronym STEM is used. The main principles of this approach in education:

- emphasis on student project activities;
- orientation of educational tasks towards practical application in life;
- coverage of key disciplines necessary to train a specialist in the field of modern technologies;
- interdisciplinary nature.

The idea of STEM originated in the USA in 2001 and received support not only from the government, but also from large corporations working with modern technologies (Xerox, Intel, etc.). Now the approach is used in Russian education, as well as in the UK, France, Canada, China and other countries.

The goal of the approach is an emphasis on practice, the real application of knowledge, benefits for individuals and society, and the disclosure of creativity. Particular emphasis is placed on engineering and robotics - areas that will dominate the world in the not too distant future.

Singapore method

The city-state of Singapore in Southeast Asia has also contributed to the implementation of digital technologies in education. An educational methodology was developed here, which over time began to be used in the rest of the world. Its effectiveness is confirmed by the fact that Singaporean children demonstrate a high level of preparedness in the field of technology, exact sciences, and engineering [6].

The main principles on which the methodology is based:

- adaptation to the new reality - for example, instead of prohibiting children from using cell phones in class, teachers figure out how to make the gadget part of an exciting learning process;
- focus on the experience of world leaders in the field of education;
- high requirements for teacher training;
- emphasis on developing independence and practical skills that will be useful in real life and work.

Results and Discussion

Let's give examples of the use of some advanced educational technologies in higher education institutions today.

Virtual and augmented reality

Virtual reality (VR) and augmented reality (AR) are technologies that provide maximum immersion in an artificially created space. These technologies are being used more and more often in teaching, since their effectiveness cannot be disputed. The main advantages of VR and AR in training:

- high level of student involvement – the effect of presence makes the learning process entertaining;
- immersiveness – the student interacts not with a flat picture or text, but with three-dimensional objects, which allows for complete integration into the process and stability of variable factors;
- interactivity – students can practice cases and receive instant feedback.

Let's give an example. The discrete mathematics lesson covers the topic “Turing Machine”. If earlier the teacher simply talked about it and the students could look at the images in the textbook, now, having put on virtual reality glasses, they themselves will seem to find themselves in front of the machine and will observe the whole process of Turing's work, where secret codes are read, and so on.

And this applies not only to discrete mathematics. Students will be able to “see” famous writers and poets, the processes occurring inside a nuclear reactor, the division of cells of a living organism, see ancient temples, statues, and witness important battles. There is no doubt that this way the level of interest in learning will be much higher, which means that the effectiveness of education will increase [8].

Fishbone

This word can be translated as fish skeleton. The technology is based on a schematic diagram of a fish skeleton, proposed by Japanese professor Ishikawa. The “head” of the fish is the problem, and the “tail” is the solution. Between them is the spine with ribs extending from it. The upper “bones” represent the causes underlying the problem, and the lower ones represent the facts confirming the existence of these causes.

The approach is aimed at developing in students the ability to see cause-and-effect relationships, analyze, and distribute factors according to degree of significance. Fishbone allows you to work both individually and in groups.

Let's give an example. To make the perfect disjunctive normal form, we perform the expansion of Boolean functions by variables.

"Fish skeleton" drawing - Allows you to describe a number of problems and solve them. Develops the skills of systematic thinking, structuring, and analysis. In separate subgroups, the top "bone" represents a small problem, and below, the solutions to these small problems are written.

Take, for example, the reduction of Boolean functions with three variables to a perfect disjunctive normal form:

$$f(x, y, z) = \bar{y} \leftrightarrow x\bar{z} \text{ (picture 1.)}$$

$$\text{distribution of variable } x - x(\bar{y} \leftrightarrow \bar{z}) \vee \bar{x}y$$

$$\text{distribution of variables } x \text{ and } y - xyz \vee \bar{y}x\bar{z} \vee \bar{x}y$$

$$\text{distribution of variables } x, y \text{ and } z - xyz \vee \bar{y}x\bar{z} \vee \bar{x}yz \vee \bar{x}y\bar{z}$$



Picture 1. Fish skeleton

It can be seen that the expansion of the Boolean function over all variables leads to a perfect disjunctive normal form. After completing the given task, it can be shown whether it was done correctly or incorrectly by moving the fish using animations or multimedia.

"Yes or no" game.

In traditional education, this method is also called "Working with red and green cards". The method is used based on the organization of the following activities:

- according to the number of students in the group, the teacher prepares red and green cards for each student and a questionnaire on the topic;
- it is important to include questions that can be answered in the form of "yes" or "no" in the questionnaire;
- red and green cards are distributed to each student;
- students are taught that green cards mean "confirmation" and red cards mean "denial";
- students respond to the teacher's questions based on showing the cards that mean "confirmation" or "denial".

This method can be achieved quickly and easily by pressing the "red" and "green" buttons on the questionnaire using digital learning tools (table 1).

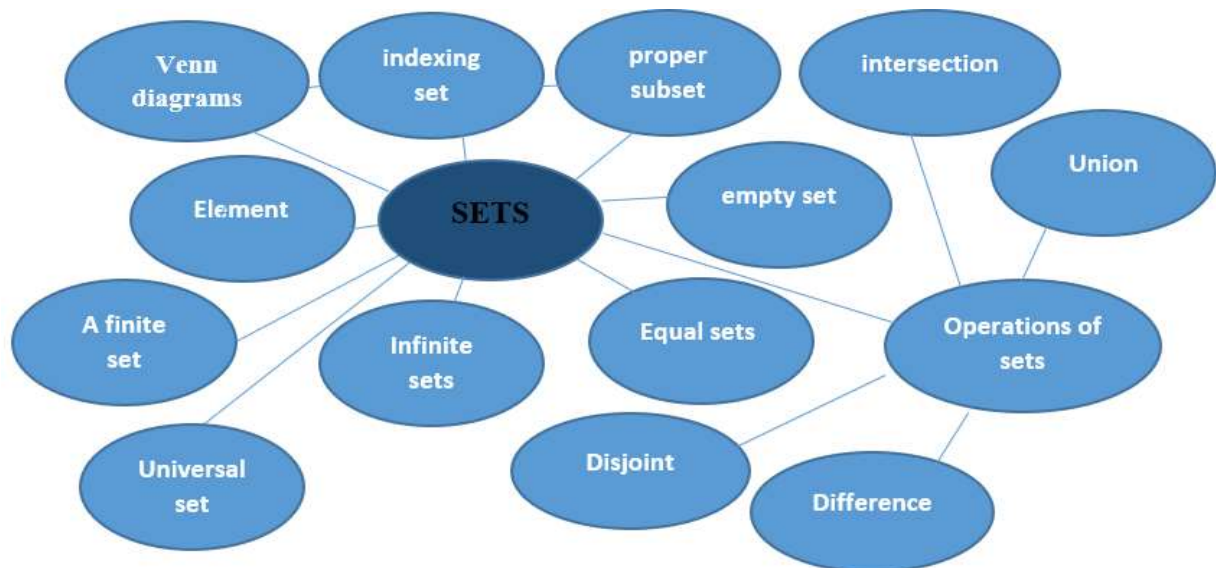
1.	Normal forms of formulas are of great importance in applications of logic algebra in contact and relay-contact circuits, discrete techniques and other problems of mathematical logic (green).
	<div>YES</div> <div>NO</div>
2.	A formula of the form $x_1^{\sigma_1} \vee x_2^{\sigma_2} \vee \dots \vee x_n^{\sigma_n}$ is called an elementary disjunction (green).
	<div>YES</div> <div>NO</div>

3.	An example of a Conjunctive Normal Form (CNF) is $xy \vee \bar{x}z \vee x\bar{y}z$ (red)	<input type="button" value="YES"/>	<input type="button" value="NO"/>
4.	Formula $(x \vee y) \wedge (\bar{x} \vee z) \wedge (x \vee \bar{y} \vee z)$ is an example of disjunctive normal form (DNF) (red).	<input type="button" value="YES"/>	<input type="button" value="NO"/>
5.	Every formula of elementary reasoning has an equivalent conjunctive normal form formula (green).	<input type="button" value="YES"/>	<input type="button" value="NO"/>
6.	The conjunction of elementary disjunctions is called the conjunctive normal form of the formula (green).	<input type="button" value="YES"/>	<input type="button" value="NO"/>
7.	The disjunction of elementary conjunctions is called the disjunctive normal form of the formula (green).	<input type="button" value="YES"/>	<input type="button" value="NO"/>
8.	A formula of the form $x_1^{\sigma_1} \cdot x_2^{\sigma_2} \cdots x_n^{\sigma_n}$ is called an elementary conjunction (green).	<input type="button" value="YES"/>	<input type="button" value="NO"/>

Table 1. Yes or no

Cluster method.

In this work, we can use the cluster interactive method to teach the basic concepts of the theory of sets and operations on them. The cluster method is a visual, schematic representation of the educational material, which helps to get an idea of the studied concepts, to understand them, and to clearly describe their components and interconnections. This method also helps to develop memory and self-assessment of the student's knowledge (picture 2).



Picture 2. Cluster method

The next method chosen for use is the "Find a match" method. In this method, ideas, formulas, drawings, graphs, etc. should be presented on the right side corresponding to the concept on the left side of the table. So, the concept on the left is studied, the corresponding correct answer is found from the column on the right and combined with an arrow (line, symbol). In the following table, the main concepts on the topic "Normal form of formulas" are presented, and it is required to find examples (formulas) that correspond to these concepts (table 2).

Students get to know the examples, prove and find a mutual agreement, showing the answer with an arrow (line, symbol).

Elementary disjunction	$(x \wedge \bar{y} \wedge y) \vee (x \wedge y \wedge \bar{x})$
Elementary conjunction	$x \wedge y \wedge z$
\bar{J}	$\bar{x} \vee \bar{y} \vee \bar{z} \vee \bar{t}$
DNF	$(x \wedge \bar{y} \wedge \bar{z}) \vee (x \wedge y)$
CNF	$(\bar{x} \vee \bar{y} \vee \bar{z} \vee x) \wedge (x \vee y \vee \bar{t})$
J	$(\bar{x} \vee \bar{y} \vee \bar{z}) \wedge (x \vee \bar{t})$

Table 2. Find a match

"Find the match" method is one of the game methods, which encourages all students to focus and actively participate [7].

Mind-maps are a method of presenting any process or event, thought or idea in a consolidated, systematized, visual (graphic) form.

Mind-maps are a graphic representation of information on a large sheet of paper. The map reflects the relationships (content, cause and effect, associative, etc.) between concepts, parts and properties of the field under consideration. It is more understandable than expressing ideas in writing using words. After all, describing through words brings out a lot of unnecessary information and forces the brain to work in a way that is not typical for it. As a result, this condition leads to loss of time, lack of attention and rapid fatigue.

Perceptual maps help to make the right decision:

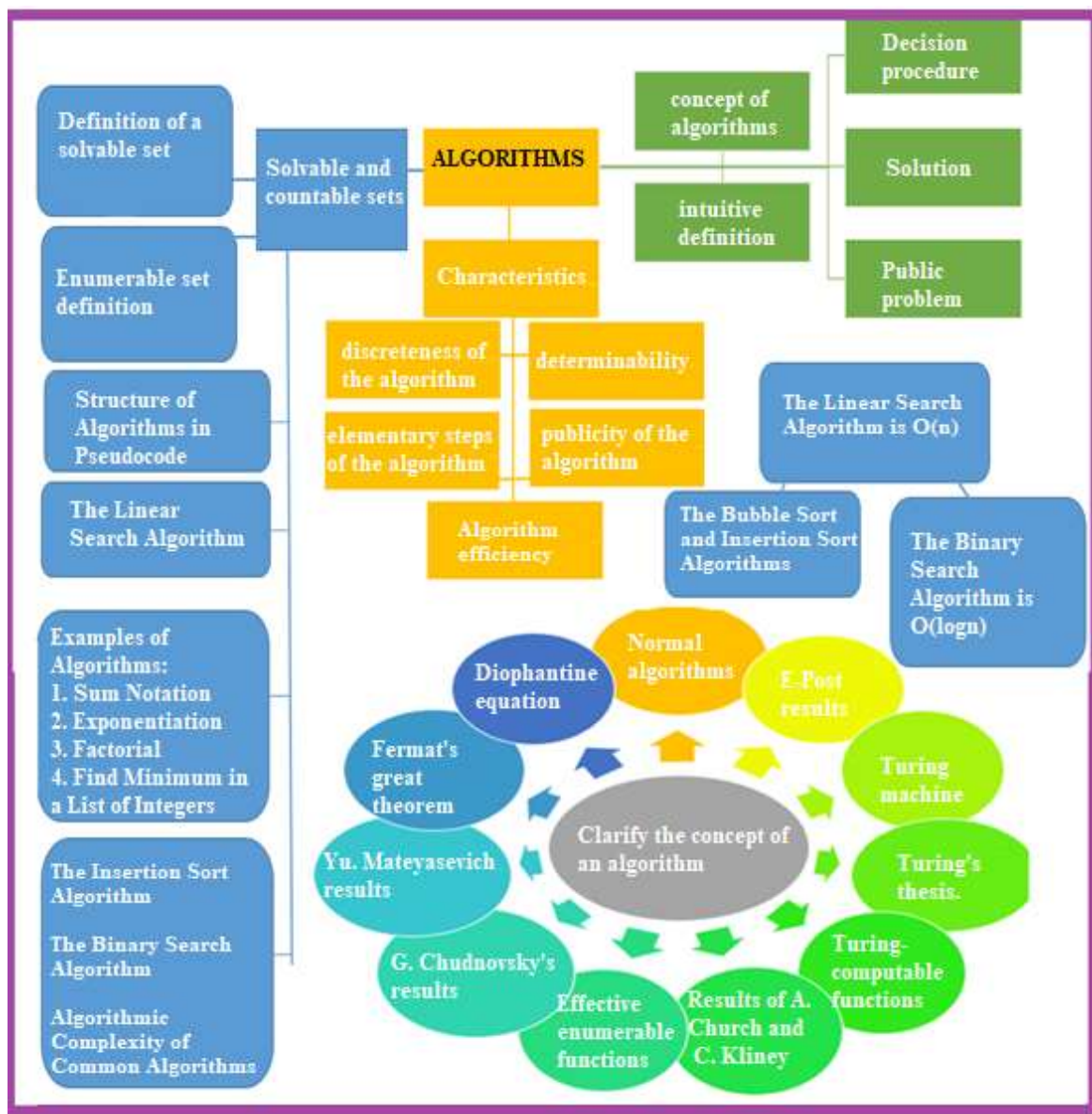
- A cognitive map allows you to gather all the information you need to solve a problem on one sheet and look at it as a whole.
- Perceptual maps help not to lose sight of the negative and positive aspects of this or that solution.
- Perceptual maps activate the process of associative thinking, and it allows to see the important factors that caused the mistakes made during the traditional analysis.
- In addition, the use of images and colors in perceptual maps activates intuition, which can influence the correctness of decisions being made.

Mind mapping can help you prepare for your presentation. How is the preparation for the presentation going? A person reads articles and books, writes a synopsis of them. In order not to get lost in the variety of collected materials, it is very useful to organize them in the form of perception maps. It allows you to shorten or expand the output by simply deleting or adding a branch in the perceptual map during output. A cognitive map made at a high level helps not to get lost and not to lose the main idea, while preserving the general content of the speech.

The advantage of a perceptual map over a text plan is obvious: it is much easier to remember a picture with ten keywords than ten pages of text; armed with a perceptual map, it is very difficult to distract the presentation speaker with a question or in any other way; the cognitive map can be presented as a visual aid (slides, posters), so that students remember the main idea better and do not get distracted looking everywhere; at the end of the study, printed copies of the perception maps can be used as handouts.

The use of cognitive maps in the teaching process is very useful. It is very necessary to use cognitive maps in summarizing lectures, writing term papers (abstracts, graduation qualification papers, dissertations), in the process of understanding and remembering a large amount of information. Information presented in the form of standard abstracts (a bunch of written and filled sheets that do not differ from each other at all) causes a huge loss of time. It takes a lot of time to record the necessary information, then find and read it. Compilation of cognitive maps, together with good learning and memorization of the text, is a unique exercise that develops the ability to think creatively and creatively.

Routine and monotonous work leads to a decrease in the ability to focus on one place when receiving new material, deterioration of mental abilities and memory. What is the process of outlining a lecture for a student? It's a dull, boring exercise.



Picture 3. Mind-maps

Conclusion

Resistance to digitalization.

The use of digital technologies in learning meets with a lot of criticism and even outright resistance from parents and some education workers. Among the main disadvantages are:

- Poor development of social skills. If a student becomes overly interested in computer technology, he will be less likely to seek communication in the real world, and the level of communication with peers and teachers will be lower. Within education, this can be compensated for by organizing work in teams and creating a common project.
- Harm to health. Vision and the musculoskeletal system have truly become vulnerable areas in the age of high technology. It is necessary to place special emphasis on physical activity and regular breaks from gadgets to minimize harm.
- Device dependency. Unfortunately, this risk is inevitable. Therefore, it is necessary to develop and improve standards regarding time on the computer, smartphone and tablet, and to focus on hobbies that are not related to IT.
- Job cuts. The lack of paperwork and a change in the role of the teacher will indeed lead to a reduction in the number of required employees in educational institutions [9].

Pros of digitalization

- Individual education. With classical education, it is impossible to “customize” the educational process personally for each student. Therefore, lagging behind appear in a class or group. Digital technologies in education make it possible to adjust the program according to the abilities and speed of each student. For example, if there is a platform for recording lessons, you can return to a complex topic at any time and study it again.

- Development of self-learning skills. When using digital educational tools, students learn to acquire knowledge on their own. They search for information, analyze it, weed out the unnecessary, and highlight the main thing. In other words, digital learning provides the bait, not the fish: students learn to learn. This approach not only helps to gain knowledge, but also develops cognitive abilities, critical thinking, independence, and skills in working with information. It also promotes a positive attitude towards education.
- High motivation to study. Students who use modern learning tools are more involved in the educational process. This is due to the fact that the material is presented in a more interesting and convenient format; it is easier to master than with the traditional approach. For example, a student would be more willing to study a presentation with graphs, drawings, and short descriptions than to read a paragraph from a textbook.
- Ability to explain complex things. Digital technologies in education open up new opportunities for learning. So, if previously the structure of the solar system could only be shown on models or pictures, now there are detailed videos where even small details are clearly shown. And an online course is not only video and text, but also interactive tests and gamification elements.
- Simple knowledge testing and reporting. Assessing students is very simple: there are special platforms on which you can complete tasks with automatic checking. The teacher does not need to calculate the results manually: as soon as the student completes the work, a report will appear in the teacher's personal account.
- For courses, you can also create any format for testing knowledge - from tests to detailed answers. For example, the SkillSpace platform helps you create tasks using a template. You can activate automatic checking, and you won't have to waste time reviewing tests.
- Advantageous format. When using digital technologies, you do not need to buy textbooks, notebooks, additional manuals, or stationery. All educational material is on one platform, and students do their homework here [10].

During the last 10 years, it can be observed in the scientific work of scientists that conducting lessons on the basis of a well-developed project using digital educational technologies leads to an improvement in the quality of education by 10-23 percent. The use of digital technologies in the implementation of educational programs is a necessary but not sufficient condition for improving the quality of education. It is necessary to combine digital technologies with traditional technologies on the basis of mutual reinforcement or complementation of their didactic capabilities. At the same time, each of the integrated technologies should have high didactic capabilities, because the automation of inefficient processes only increases their inefficiency.

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