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VISUALIZERS OF ALGORITHMS AS EFFECTIVE MEANS OF INFORMATION TECHNOLOGIES IN EDUCATION

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ABSTRACT

The article discusses issues related to the use of visualization methods in teaching. The place and role of visualization of educational information in solving a number of pedagogical tasks, such as ensuring the intensification of learning, enhancing educational and cognitive activities, the formation and development of thinking, visual perception, figurative representation of knowledge and educational actions, knowledge transfer and pattern recognition, are stated. As an example, the structure and capabilities of the emulator of sorting algorithms developed in the Delphi 7 programming environment are considered.

KEYWORDS: ***educational process, "Theory of Algorithms", teaching methodology for the subject "Theory of Algorithms", visualization of educational material.***

INTRODUCTION

Today information technology is one of the most dynamic branches of knowledge, which requires you to constantly be aware of its changes and allows you to use the latest technologies in order to maximize the positive effect in the intellectual development of the individual. One of the priority directions of the process of informatization of modern society is informatization of education, which is a system of methods, processes and software and hardware.

Unfortunately, information technologies are not sufficiently introduced into the traditional training system for the "Theory of Algorithms" course, since due to its fundamental nature, it traditionally refers more to theoretical computer science. After analyzing the existing teaching methods of the "Theory of Algorithms" course, it can be concluded that understanding the content of the fundamental disciplines of subject preparation contributes to the formation of a future science teacher in computer science, an appropriate informational, mathematical culture, as well as providing the base necessary for future professional activities. Given the specifics of the concepts that operate with the fundamental disciplines of subject preparation, including the "Theory of Algorithms", namely, their formalization and a high degree of abstraction, the learning process should be built using methods and means that ensure its maximum visibility, strict consistency of presentation, which can support theoretical students thinking [1]. The main objective of the course is to introduce students to the means that allow the transition from an informal statement of the problem to its description in the form of a formal system. The traditional teaching materials of the course "Theory of Algorithms" (textbooks, teaching aids and task books) reflect the system of didactic units of the discipline, but they do not have a high degree of visibility necessary for a generation whose living information space is shifted from text to figurative, visual. These limitations of teaching aids prevent students from deep understanding of the content of the course "Theory of Algorithms" and mastery of fundamental subject skills. Despite this, the studies do not pay enough attention to the features of developing a holistic methodological training system based on the use of information and communications technology tools, do not take into account the features of the specialties in which the discipline is studied, and does not examine the impact of the use of information and communications technology tools on the quality of education [2,3].

According to the curriculum, "Theory of algorithms" is studied in the second year. Usually, this section of theoretical informatics is perceived by teachers and students as predominantly abstract and

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implies the development of educational material through lectures and practical exercises, which involves solving a sufficient number of problems. The goal of this course is to provide an understanding of the concept of an algorithm and a computable function, which are fundamental concepts of computer science and mathematics. This is where the consideration of abstract concepts that the student has not encountered before begins. The systematic study of algorithms and various models of computation leads the student to study a special discipline, bordering between mathematics and computer science - the theory of computability. Within the framework of the theory of computability, the concept of a computer is formulated and it is shown that the implementation of all possible transformations of information can be done on one universal device using a suitable program and appropriate coding. The topics "Turing Machine", "Post Machine" and "Normal Markov Algorithms" have a "programmatic" nature and are closer to information technology in their content. These concepts define the same thing - the algorithm, therefore, when solving the problems of this topic, you can use the material from the previous topic, as well as various tasks from the school course in mathematics and computer science (for example, to build algorithms for GCD, LCM, etc.). When studying these topics, we propose to solve problems using various constructors and interpreters (for example, a block diagram constructor, interpreters of the Turing machine and normal Markov algorithms)[4]. An example of such tasks can be the following: "Determine the purpose of the algorithm according to the block diagram (the block diagram is made in the constructor with the possibility of step-by-step verification of its operation with the input initial data)". Note that the use of a computer is due to the ability to visualize individual stages of work. Tasks on the topics "Turing Machine", "Post Machine" and "Normal Markov Algorithms" involve a large amount of computational work, and informatization of the educational process allows you to automate this routine work. At the same time, the openness of the computational processes performed by programs has a great teaching effect, since it allows one to trace and understand the connection between the initial data and the computation process. Using interpreters (for example, Algo2000) is, in our opinion, the best way to visualize the learning process in the course "Theory of Algorithms" [5].

MAIN PART

The term "visualization" comes from the Latin visualis - perceived visually, visual. Visualization is the process of presenting data in the form of an image in order to maximize the convenience of understanding it; giving a visible form to any conceivable object, subject, process, etc. In pedagogy, in particular in the methodology of teaching the exact sciences, the meaning of the concept "visual" is always based on the demonstration of certain objects, processes, phenomena, the presentation of a finished image given from the outside and not born and carried out from the internal plan of human activity. Therefore, depending on the properties of didactic visual aids, the level of activation of the mental and cognitive activity of students depends. In this regard, the role of visual models for the presentation of educational information increases, allowing one to overcome the difficulties associated with learning based on abstract logical thinking. Depending on the type and content of educational information, methods of compaction or step-by-step deployment using a variety of visual means are used. At present, the use of cognitive visualization of didactic objects seems promising in education [6]. This definition actually includes all possible types of visualization of pedagogical objects, functioning on the principles of concentration of knowledge, generalization of knowledge, expansion of orientation and presentation functions of visual didactic means, algorithmization of educational and cognitive actions, implemented in visual means.

By visualization, we mean the general name for the methods of presenting information or phenomena in a form convenient for visual observation and analysis. At the same time, the role of visual models for the presentation of educational information increases, allowing one to overcome the difficulties associated with learning based on abstract logical thinking. Computer visualization is understood as the technique of translating abstract representations of objects into geometric images, which enables the researcher to observe the results of computer modeling of phenomena and processes. The following types of computer visualization are traditionally distinguished: scientific visualization; software visualization; information visualization [7]. Scientific visualization refers to the use of computer graphics and human-machine interaction to represent data about objects, processes and phenomena that are modeled in scientific computing. Software visualization is understood as a set of techniques for using graphics and human-machine interaction tools used for a better understanding of concepts and effective operation of software, as well as for the specification and presentation of software objects in the process of creating programs. The term information visualization refers to the visual description and presentation of abstract information obtained as a result of the process of collecting and processing data of various types and purposes. Typically, this data does not have a natural and obvious graphical presentation. Information visualization combines scientific visualization and human-machine interaction methods. Information visualization methods are widely used in all areas

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using information technology. This also applies to education.

RESULTS AND DISCUSSION

Algorithmization is an important step in solving any problem using a computer. The effective activity of a specialist in the field of information technology depends not only on proficiency in a specific programming language for solving applied problems, but also, to a greater extent, depends on the quality of knowledge in the field of building well-structured algorithms for processing information represented by various data structures [8,9], as well as the accumulated experience in solving applied problems. Based on these considerations, it can be argued that, for the successful mastering of the mechanism of the algorithms, a necessary condition is a visual description of the algorithm for each stage of its execution. Visualization in the educational process is the process of presenting information, data, knowledge in the form of an image, with the goal of maximizing the convenience of their perception, understanding and analysis. For example, a visual representation of the algorithm will allow the student to see and better understand which structural elements are used in the design of the algorithm, how the logic of their interaction is described, which real objects correspond to certain elements in the problem being solved. The visualizer of algorithms can be used as a visual teaching tool allowing to implement such an approach. Let's note the distinctive characteristics of visualizers: interactivity and visibility in the control of the visualization process by the user; ease of use of the visualizer interface; displaying the progress of the algorithm; availability of explanations; support for two visualization modes: step by step and automatic. In the educational process, visualizers of algorithms can be used if the following requirements are met: display of input and output data in a visual form, which demonstrates the execution of the algorithm; output of comments to the execution of the algorithm, which would explain all the actions performed; step by step display of the operation of the algorithm - students should be able to follow the actions of the execution of the algorithm from beginning to end, step by step. The Delphi 7 visual programming environment can be used as software for the development of the visualizer of algorithms[10]. The Delphi 7 environment has rich opportunities for designing the application interface and implementing visual reproduction of algorithms, in particular, the Timer and Image components can be used to animate the process of sorting array elements. And also animation can be implemented using the Canvas object and its graphic methods. For textual explanations of the operation of algorithms and process control, such components as Button, RadioButton, Label, Memo are used. Components such as Edit, StringGrid, ComboBox are used to implement data input. In addition, there is a group of graphic components Shape and PaintBox, which can be used to display graphic objects on the form. As an example, we will give a description of the emulator of sorting algorithms developed in this environment. The application is designed to sort the elements of the visualization array and compare the time complexity of algorithms. The functionality of the visualizer includes: generation of an integer array of a given size; sorting an integer array using bubble sort (Bubble sort), quick sort (QuickSort), sort by inserts (Insert sort) and table sorting; determining the time complexity of algorithms, creating a comparative table of the time complexity of algorithms, reading the values of the elements of the sorted array from an external file and writing the sorted array to an external file (Fig. 1-2). The application also visualizes Bubble sort, QuickSort, Insert sort, Merge sort, and Heap sort (Fig. 4).

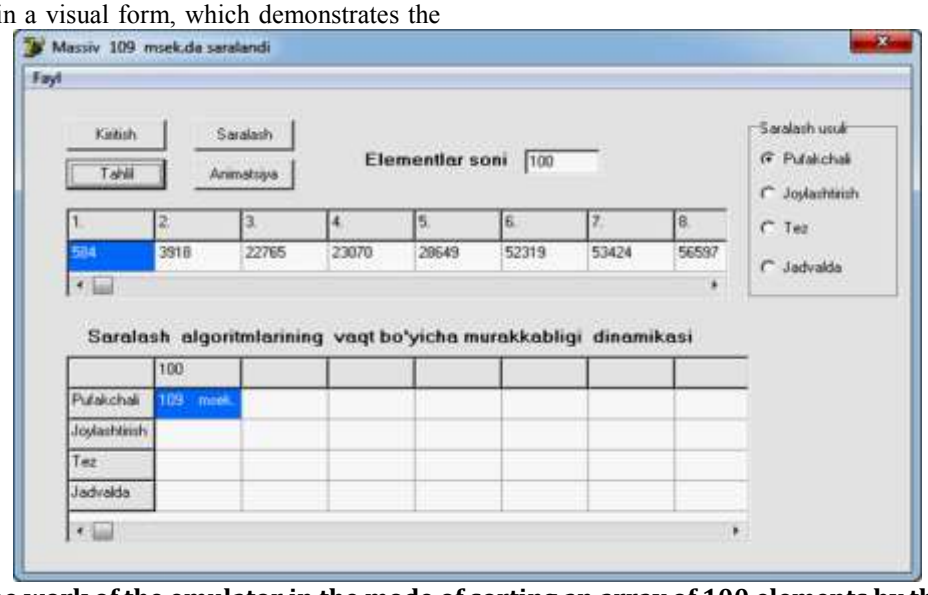

Fig. 1. The work of the emulator in the mode of sorting an array of 100 elements by the bubble algorithm.

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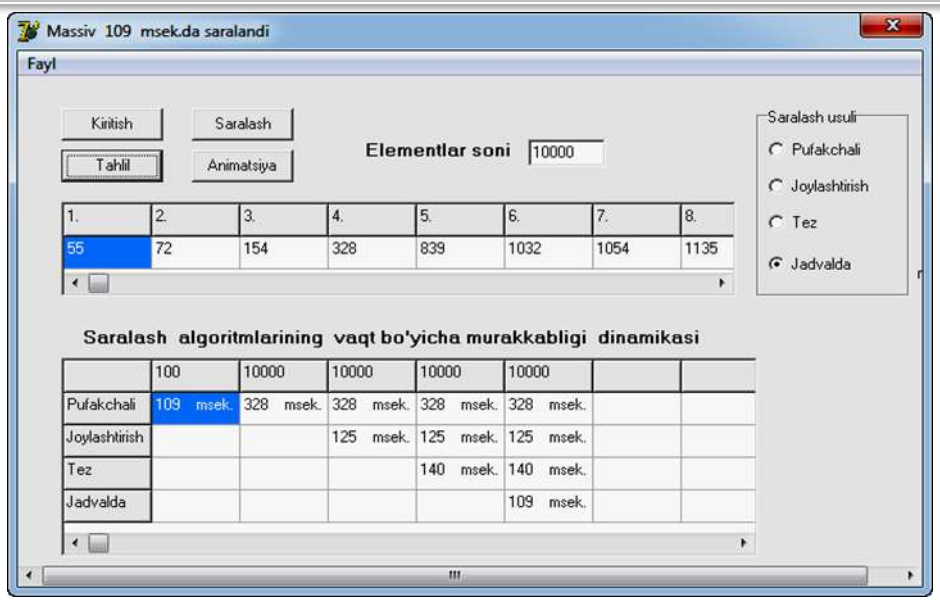

Fig. 2. The work of the emulator in the mode of creating a comparative table of time complexity of algorithms.

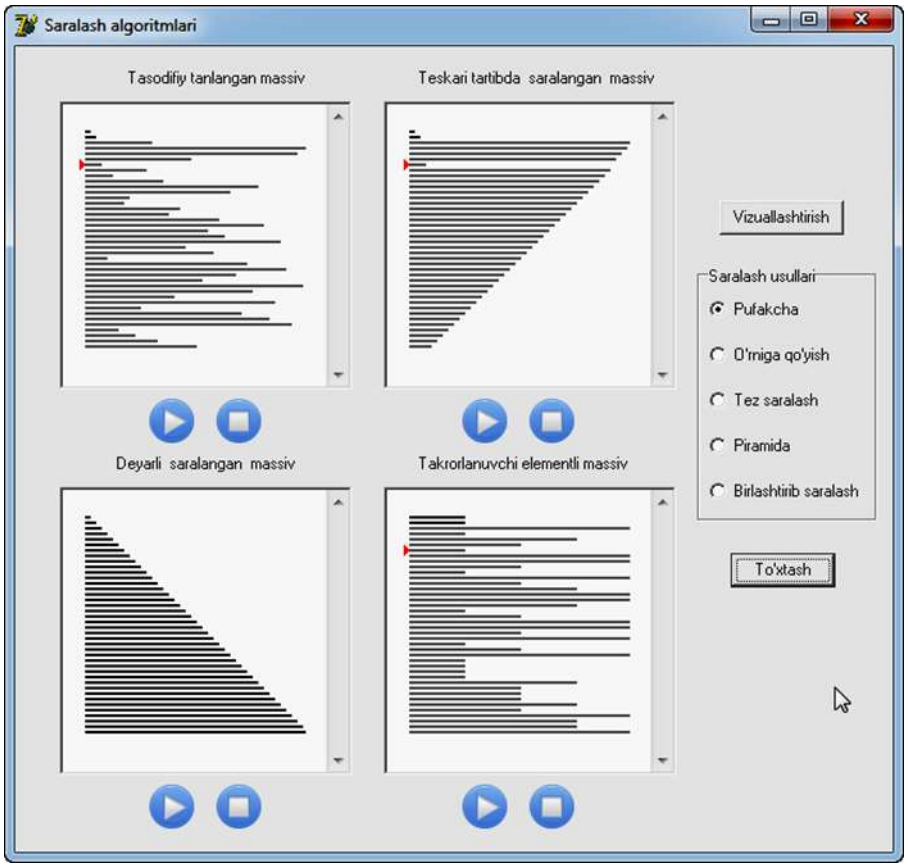

Fig. 3. The work of the emulator in the visualization mode of the algorithms.

CONCLUSIONS

Visualization of educational material opens up the opportunity not only to bring together all the theoretical calculations, which will allow you to quickly reproduce the material, but also to apply schemes to assess the degree of mastering the topic under study. In practice, the method of analyzing a specific diagram or table is also widely used, in which the skills of collecting and processing information are developed. The method allows trainees to be actively involved in the application of theoretical information in practical work. A special place is given to joint discussion, during which there is an opportunity to receive prompt feedback, to

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understand better oneself and other people. Summarizing what has been said, we note that, depending on the place and purpose of visual didactic materials in the process of forming a concept (studying a theory, a phenomenon), various psychological and pedagogical requirements should be presented to the choice of a certain structural model and a visual display of the content of education. When visualizing educational material, it should be borne in mind that visual images shorten the chains of verbal reasoning and can synthesize a schematic image of a larger "capacity", thereby condensing information. Another important aspect of using visual educational materials is to determine the optimal ratio of visual images and verbal, symbolic information. Conceptual and visual thinking in practice are in constant interaction. They reveal different sides of the studied concept, process or phenomenon. Verbal-logical thinking gives us a more accurate and generalized reflection of reality, but this reflection is abstract. In turn, visual thinking helps to organize images, makes them holistic, generalized, complete. Thus, the visualization of educational information allows you to solve a number of pedagogical problems, such as:

• Ensuring the intensification of training;

• Activation of educational and cognitive activities;

• Formation and development of critical and visual thinking; visual perception;

• Figurative presentation of knowledge and learning activities;

• Knowledge transfer and pattern recognition;

• Improving visual literacy and visual culture.

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