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THE METHOD OF USING PHYSICS MODELS AND VISUALIZATIONS IN PHYSICS

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A B S T R A C T	K E Y W O R D S
Teaching physics at school helps to increase students' knowledge about existence and the environment. Today, the development of continuous education and the introduction of international technologies into public education are improving in our country. The problem of using gaming technologies for teaching schoolchildren to solve physical problems is discussed. The possibilities of a virtual environment for organizing gaming learning activities are considered. The analysis of the domestic and foreign gaming resources in physics presented in the open access is given. The necessity of replenishing the modern resource base of this type, including the section of computer games for training sessions on solving physical problems, is substantiated.	visual literacy; cognitive graphics; computer models; Information Technology; visualization; pupils; physics; methods of teaching physics; methods of physics at school; technology; methodology of teaching technology; methodology of technology at school; educational activity; studying process.

Introduction

The social demand of a society developing along the path of the "digital economy" is associated with the requirements for its citizens, who must be able to use visual information. In our lives, we are surrounded by many types of visualization: from popular infographics, animated models, virtual and augmented reality, to complex digital twins in a professional environment to explain workflows and complex structures of various nature.

A person who receives information visually comprehends it, and mental models arise in his mind, the accuracy of which determines the result of further activity. Thus, the ability of a person to correctly interpret, "read" the visualized information becomes the most important condition not only for his professional success, but also for his entire life activity. It is no coincidence that back in 1968, John Debes proposed the term visual literacy, which today finds its further development and content.

In pedagogical practice, various methods of visual structuring are used (flow charts, graphs, reference signals, logical semantic models, mental maps, infographics, graphic and animated images, etc.), which differ in the amount of knowledge presented, the complexity of working with them, in the degree of detail, in the degree of proximity to real three-dimensional objects, etc.

Visual (natural) representation of the studied objects, processes in the lessons of physics or technology, visual and tactile perception of their properties, connections and correlation with the material of other objects or previously studied material make it possible to quickly and clearly demonstrate individual fragments of the theory to students, focus on important points in the process of solving a problem, the variability of initial conditions, form practical actions for solving in new conditions, involve the knowledge and acquired skills of students in the process of learning areas of knowledge. ny other items.

Recently, relatively new visualization tools began to appear in the mass school - three-dimensional models (3D models) made on the basis of fabber technologies (rapid prototyping technology or three-dimensional printing).

Modeling and work with digital and full-scale models in education are associated with the objective development of production: 3D printing is actively used in medicine, robotics, engineering, industry, etc. Without this technology, modern production is impossible today.

Significant experience has been accumulated in the creation and use of various models in the educational process: static and animated 3D models, they are presented in sufficient quantities on educational sites for free use in the classroom, in addition, virtual reality models are being developed and find practical application. But at the same time, there are no recommendations on modeling and using full-scale 3D models (printing on a 3D printer, using a 3D pen) in the framework of classroom activities. So far, 3D printers and 3D pens are in most cases “fashion accessories” that show the current level of school technical support, and not effective means of achieving educational goals.

The educational standard regulates the work of students with models, for example, the study of the model, the interpretation of the results obtained on real objects, the application of the acquired knowledge in new conditions, the evaluation of the parameters of the model, the analysis of the correspondence between the model and the simulated object, process, which can be correlated with the presence of "visual literacy" among students.

However, the question arises: what natural models and how should their capabilities be used in teaching physics and technology for the effective development of visual literacy among students?

The purpose of our study was:

– in determining the possibilities of full-scale models for the formation of visual literacy of students;

– in determining full-scale 3D models that can be created on the basis of educational material in physics and technology and used in class and lesson activities of students;

– in determining the readiness of practicing teachers of physics and technology to use full-scale 3D models in educational activities.

In the scientific studies of Bashkir scientists, we find confirmation that in order to activate the cognitive abilities of students and the formation of digital competencies, it is proposed to assign a special role to cognitive visualization methods. The choice of the direction of cognitive visualization is determined by the following aspects:

– the efficiency of assimilation of educational material increases if visualization in training performs not only an illustrative, but also a cognitive function;

- the development of didactic tools that take into account the psychophysiological properties of the visual organ, touch and human thinking, allows the most rational and successful use of the possibilities of the visual channel;

– thanks to the ability to present large amounts of information in a concentrated form, convenient and adequate

Abroad, visualization possibilities are being actively developed: the specifics of memory and its support with the help of visual images are being studied; the role of visualization in the processes of cognition and learning is studied and visual means of infographics, mental maps, 3D models, including printed ones, are designed.

In particular, S. Stokes considers existing teaching methods in connection with the visual objects used by teachers; gives examples and analyzes the results of visualization made on the basis of digital technologies; formulates the main provisions of the concept of visual literacy, which is defined by scientists as the ability to correctly perceive and interpret images, as well as the ability to create them in order to translate educational information, scientific ideas and directions in a compact way.

The first type of knowledge (declarative) includes visualizations that allow obtaining information about certain phenomena, events, object properties, dependencies.

The second type of knowledge (procedural) refers to visualizations (newspaper infographics, information visualization aesthetics), which not only collect data and visualize it, but are also capable The authors refer to these three categories as analytical visualizations, communicative visualizations, and formative visualizations. We believe that natural 3D models used in the classroom are formative visualizations: they are used as "support" in the transfer of knowledge in the classroom, represent the object, process or phenomenon being studied, and can be used when organizing work in groups.

In parallel with infographics, the concept of visual literacy arose, which was proposed by John Debes, founder of the International Visual Literacy Association (IVLA): "Visual literacy is a set of abilities that allow an individual to effectively find, interpret, evaluate, use and create images and other media things. Knowledge and skills supported by visual literacy allow the person who owns them to understand and analyze the context of images, their cultural, aesthetic, ethical, intellectual and technical components".

Visual literacy is in demand when working with cognitive graphics. In his work on cognitive graphics, S. V. Chebanov traces the emergence of the term "cognitive graphics" as a section of cognitive science from schematic drawings to "cognitive computer graphics". It is important for educational activities that cognitive graphics and cognitive computer graphics have the same essence - the representation of an idea, task, problem in such a way that it describes the course of a solution or makes it possible to resolve the situation. For students, the opportunity opens up to study the process of creating scientific knowledge, and not "absorption" of its results. The computer implementation of the idea of cognitive activity in digital models expands the possibilities for visualization and analysis.

Visualization is defined as "the folding of mental contents into a visual image", which can serve as a support for further mental and practical activities. It is given the significance of a special psychological mechanism of "translating an invisible mental image into a visible, visible image". Visualization is also called the "epistemological mechanism" - an intermediate link between the educational material and the learning outcome, eliminating minor details.

There are different interpretations of this term itself. For example, it is proposed to distinguish between information visualization and knowledge visualization. The first is defined as "the use of computer applications for the graphical representation of abstract data", the second is defined - again in the context of information disciplines - as a set of graphic elements and links between them used to transfer knowledge from an expert to a person or group of people, revealing the causes and purposes of these links in the context of the knowledge being transferred.

In our previous works, an analysis of the "cognitive graphics" of digital educational models was presented in the study of mathematics and technical disciplines. It was considered as a polysemic concept, and it was noted that cognitive graphics and computer cognitive graphics have the same

essence - the presentation of an idea, task, problem in such a way that it describes the course of a solution or makes it possible to resolve the situation. It is determined that this allows students to proceed to the study of the process of creating scientific knowledge, and not
"absorption" of its results. Visibility, perceptibility and interpretability create the possibility of cognitive analysis of the digital model and obtaining new knowledge based on this analysis.
In the present study, the school material of textbooks on physics and technology of all classes by various authors was analyzed in order to select the material for creating full-scale 3D models. We paid attention to the content of the educational material in order to create a full-scale 3D model that would have the ability to:
1) additional visualization of the teacher's story (for example, the model of the Leaning Tower of Pisa when the teacher tells about Galileo's experiments or models of different shapes and volumes when discussing physical terms: mass, volume of matter), that is, the transformation and sharing of model data and information about it;
2) natural visualization to consolidate knowledge (for example, a model for demonstrating the phenomenon of hydrostatic paradox);
3) a variety of visualization of the created models for the implementation of the creative activity of students (for example, the creation of a furniture set or a unique design of stairs or roofing);
4) systematic visualization at the end of the study of any topic of the course (for example, a model of an electric power transmission system, starting from a power plant and ending with household consumption);
5) visualization for finding a solution (when solving problems);
6) visualization for organizing and evaluating the project activities of students (for example, creating models of unique bridges in Russia with a discussion of their design and principles of construction).
They should be used in the classroom, and work with them should be aimed at developing students' visual literacy: obtaining information from a visual object and using it in real life problem solving, correlating visual information with the material being studied, developing the skill of critical visualization, which means applying critical thinking skills to image analysis.

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