Creation of the Simplest 3d Models for Additional Education

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Abstract: Introduction. This article describes the features of the TinkerCAD program that are specific to creating 3D models. The ability of a computer to reproduce information simultaneously in the form of a graphic image, text, speech, sound, video, remember and process data at a high speed allows specialists to create new activities for children; and therefore it is necessary to introduce information technologies into the system of initial education and training. The practical experience has proved that children's motivation to study is growing fast, and the level of cognitive abilities is increasing too. Information technologies provide a personal-oriented approach, the capabilities of the computer allow to increase the volume of the offered material for familiarization. In addition, schoolchildren have the same program material to repeat and many forms of material presentation are of great importance. Technologies used in the organization of additional training in IT-technology lessons should be aimed at activity approach. This will help to differentiate students and help them to adequately evaluate themselves without affecting their self-esteem. The basis for conducting classes may be design and research technologies, which ensure the systematic immersion of the child into the process of independent construction of new knowledge and allow to carry out training of different levels. The aim of the article is to present and summarize the possibilities of using 3D models in the secondary school education space. Methodology and methods are based on the analysis of psychology and pedagogical, scientific and methodical, popular scientific and educational literature, Internet sources; surveillance, interviews with students and teachers; monitoring and analyzing the activities of teachers and students with a view to studying the state of the problem under study. Results. Innovative methods and methods of teaching in the field of 3D modeling and their influence on practical work of students have been studied. Scientific novelty. The possibilities of 3D modeling in the field of additional education were analyzed. Practical importance. 3D objects have been investigated, in particular the program is TinkerCAD as a technology of additional education.

Keywords: the TinkerCAD program, 3D-objects, informatization, education, additional education, technologies of additional preparation.

INTRODUCTION

The need for talented, well-trained specialists who can cope with constantly emerging new tasks, psychologically resistant to the speed of changes in the modern information space, is becoming increasingly obvious. The training of these specialists is the main task of the modern educational system. The use of modern information technologies, including 3D modeling, can provide an additional guarantee for the career guidance for students and to increase their readiness for professional self-determination in the field of technical professions. A software product for this task is offered by Autodesk, the leader in the field of 3D modeling. The program has a well-thought-out, intuitive interface and is a convenient and simple editor for preparing models for 3D printing and is ideal for beginners. Officially, the program is called TinkerCAD, it operates online, so the user does not have to configure and install the software product. TinkerCAD has a number of advantages that allow it to be actively used in the educational process: models formed by schoolchildren can be saved on the site or on the user's local disk in STL file format; TinkerCAD works with various 3D printing services (Ponoko, Shapeways and i.Materialise) and MakerBot printers; TinkerCAD has a large palette of graphic tools and images, there are blanks for creating three-dimensional letters, numbers and other popular symbols, there is a convenient method for resizing models and deleting their individual elements; TinkerCAD is based on WebGL technology, which makes it possible to display three-dimensional graphics in a browser, so you do not need to install any additional applications to work with the program, just a browser that supports WebGL (Chrome, Firefox or Opera 12 Alpha) is enough.

Federal State Educational Standards (FSES) are a set of requirements that are mandatory for the implementation of the main educational programs of primary general, basic general, secondary (full) general, primary vocational, secondary vocational and higher professional education by educational institutions that have state accreditation. FSES was developed in the framework of solving the strategic, socially significant task of determining, aggregating and consolidating in the form of a conventional norm (social contract) modern requests to the field of education from the family, person, state and society. Education in the development of the standard was considered as the main social activity, the system-forming resource that underlies the development of civil society, it is based on the goal setting, which provides for the transition from the “catching up” to the “leading” development model of Russian education. This installation involves the rejection of direct copying of Western models of education. The priority in the formation of the Standard was the Russian value, cultural and scientific component, considering the national specifics of the domestic education system. Additional educational programs have been moved beyond state standards and, thus, are regulated by the Model Regulation on the educational institution of additional education for children. The educational program determines the content of education of a certain orientation and level. The normative documents determine the classification of continuing education programs by focus. In Art. 26 of the Law of the Russian Federation “On Education” it is written “Additional educational programs may include educational programs of various kinds, which are implemented in educational institutions of further education”.

LITERATURE REVIEW

Currently, the idea of additional education in a general educational institution has

received a new theoretical understanding and practical implementation. A great contribution to this process was made by the studies of A.A. Ermolaeva, I.N. Dolgikh, G.P. Budanova, L.N. Builova et al. Various aspects of the formation and development of the 3D modeling system of continuing education are devoted to a number of works by V.V. Apacheva, N.N. Golovanova, N.K. Trubochkina, etc.

METHODS

To achieve the goal and fulfil the tasks the following research methods were used: the analysis of psychological and pedagogical, scientific, methodical, popular science, educational literature and Internet sources; the analysis of curricula, programs, textbooks; supervision, interviews with students and teachers; observation and analysis of the activities of teachers and students in order to study the state of the problem under study. To assess the effectiveness of the tested training technology at all stages of the study, qualitative and quantitative methods of analysis were used. The influence of information educational technologies, in particular, 3D modeling on the learning process of students was evaluated by observing and analyzing the results.

RESULTS AND DISCUSSION

Modern supplementary education for children is being actively updated. Updated content education is needed for high school students and adolescents. This can be an activity in relation to an active life position, leadership qualities, providing opportunities for social hardening and social tests, life and professional and self-determination. For the system of continuing education of children, children with impaired health, with deviant behavior, and gifted children are of great interest. The creation of additional educational programs for these groups of children required a new content of education in all three of its components: education, training and development. Updating the content of activities is also necessary to ensure the participation of parents in the activities of educational institutions. Updating the content of additional education of children can be carried out through the introduction of new areas of knowledge, the implementation of a comprehensive, multilevel, differentiated education, support and development of children's creativity, the development of educational and social - pedagogical activities. The areas of knowledge such as computer technology, management, foreign languages, etc., which are not provided to children in educational institutions, are of great interest to children. There was not only a need, but also an opportunity to develop the scientific creativity of children, create labor markets for them, programs for rehabilitation, pre-vocational and initial vocational training with the issuance of certificates and other additional educational programs.

To solve problems of an organizational nature, special attention must be paid to the cooperation of school with institutions of additional education of children, since the problems of interaction are also solved at the inter-agency level. This meets the requirements of the changing cultural, socio-economic situation in the country and requires the search for the latest approaches to the forms and content of the school's interaction with the socio-cultural environment. For each stage of basic education, the system of additional education offered its own meaningful - technological module in the conditions of a specified age. At the stage of preschool childhood - the construction of a module of pre-school training programs for the formation of cognitive abilities of children

in the conditions of gaming technology. At the stage of primary education - assistance in mastering the student's position through inclusion in different educational communities, both in the system of additional school education and in the conditions of creative teams of institutions for additional education of children. At the stage of basic general education - support for the processes of personal self-determination: the expansion of the main problems in various fields of activity and the acquisition of experience in solving them. For students, the formation of a main school of readiness for the responsible choice of their own educational path is possible by providing them with the right to try their own forces in different types of activities: design, educational, game, design, art, research. At the stage of secondary complete general education, the processes of professional self-determination of a person are accompanied, and pre-vocational training is provided. At this stage of training, the research work of high school students is important, the quality of which can be improved by using the potential of the system of additional education, especially in the natural sciences, environmental, biological, artistic, technical and sports programs. In basic schools, additional educational programs are developed, both at the expense of hours for additional education, which are determined by the staffing table, and with the help of rates of institutions of additional education of children, which are transferred to schools and implemented, in particular, by teachers-part-timers of these institutions.

Within the framework of any orientation of additional education of children, the following approach is taken to determine the content of additional education. Its structure is defined by such blocks (Kozlova, 2013):

1. General orientation in the main thematic sections of the chosen direction of further education, which allows to set creative tasks independently, select funds for their solution from several probable ones, offer non-standard solutions to problems based on knowledge of information about creative associations and related fields.

2. The experience of independent implementation of various types of activities, which is based on the fact that one gets the main existing methods for solving problems and designing one's own methods, means of achievement and results.

3. The ability to receive personal meanings of one's own activity, to be relevant to its results and course, to reflect them as an opportunity to acquire goals and meanings of individual life.

4. The ability to enter into meaningful relationships and relationships with others to achieve creative goals, form active communities and be an equal participant in existing communities.

Additional education is based on the humanistic paradigm, the value - semantic element of which is the development of the child in time relative to him/herself and to the world around him/her. It forms a friendly space for children to interact with the adult world, protects the child from destructive effects, and helps him/her learn safe behavior methods. Freedom of choice is the main typological characteristic of the additional education of children, which ensures the formation of conditions that are favorable for self-realization and self-determination of the individual. The content of additional education of children is determined in the free space of human life. It is created on the basis of the achievements of culture, literature, economics, science, technology, law in the cultural context of attitude to oneself and the world, knowledge about life as an object of knowledge and the space of activity, methods of performing different types and types of activity. The child's personal growth is ensured by educational programs in three mutually penetrating and interconnected planes: in the plane of the child's personal

growth, development of his/her abilities, talents, and gifts; in the field of professional development, self-determination in the chosen activity for mastering; in the plane of communicative actions.

The content of the activities of further education can be determined on the basis of ideas, theories and concepts that are centered on a person and claiming that each person has the potential for creative and healthy growth, and all failures in the fulfillment of this potential can be overcome if a person has a real opportunity to accept self responsibility for life. Additional education creates the conditions to preserve the child's creative uniqueness, to activate the process of comprehending his own destiny in life, and to contribute to self-determination in the space of values, in choosing a profession. The peculiarity of continuing education allows different schemes for promoting a child from one educational total to another. The development of each educational program can begin with any level of readiness reached by the child to perceive the material, to solve the designated task, or to complete some task (Belash, 2016). It is the field of computer graphics that most fully and qualitatively discloses all the above possibilities of additional education. Its capabilities can be considered in more details starting with three-dimensional graphics. Three-dimensional one differs from a flat image in the construction of a geometric projection of a three-dimensional model of the scene on a computer screen using special programs. The model can be an object of the real world (buildings, a hurricane, cars, an asteroid), so an abstract model (projection of a four-dimensional fractal).

Here are the main concepts of three-dimensional graphics.

Model is an object that reflects the significant specificity of the studied object, process or phenomenon.

Three-dimensional modeling is the study of an object, process or phenomenon using the construction and study of its model.

Polygonal mesh is a collection of vertices, faces, edges, which determine the shape of a polyhedral object in three-dimensional graphics.

3D editors are software packages and programs that are designed for three-dimensional modeling.

A polygon is the smallest element of a polygonal mesh; it can be a quadrangle, triangle, or other simple convex polygon.

The graphics engine ("visualizer"; sometimes "render") is a subprogramme whose main task is the visualization (rendering) of two-dimensional or three-dimensional computer graphics.

A spline is a two-dimensional geometric object that can serve as the basis for constructing a three-dimensional object.

To obtain a three-dimensional image, the following steps must be taken (Yermolaeva, 2009):

1) Modeling is the formation of a mathematical model of the scene and objects in it.

2) Geometry (a model built using different techniques, for example, a building)

3) The scene (virtual modeling space) includes several categories of objects.

4) Rendering is the construction of a projection in accordance with the selected physical model.

5) Impacts and forces (settings of dynamic distortions of objects, which are used most often in animation).

6) Materials (information on the visual properties of the model, for example, the

color of the walls and the reflecting / refracting ability of windows).

7) Virtual cameras (selection of construction angle and projection points).

8) Light sources (power settings, directions, lighting spectrum).

9) Additional effects (objects that simulate atmospheric phenomena: clouds, light in the fog, flame, etc.).

The task of three-dimensional modeling is to describe these objects and place them in the scene using geometric transformations according to the requirements for the future image. Rendering (like English "visualization") in computer graphics is the process by which an image is obtained according to the model using a computer program. The model here is a description of any phenomena or objects in a strictly defined language or in the form of a data structure. This description may have the position of the observer's point, geometric data, the degree of presence of a substance, information about lighting, the intensity of the physical field, and so on. An example of visualization can be radar satellite images, which are presented in the form of images that are obtained using radar scanning of the surface of a cosmic body, in the range of electromagnetic waves that are invisible to the human eye. In computer graphics, often (technical and artistic), rendering refers to the formation of a flat image (picture) from a created 3D scene. Image is a digital bitmap image. In this context, visualization is considered a synonym. Visualization is one of the main sections in computer graphics, and in practice it is associated with the rest. Typically, 3D modeling and animation software packages also include a rendering function. There are separate software products that perform rendering. Depending on the purpose, there are pre-rendering, as a rather slow visualization process, which is used to create video, and real-time rendering, used in computer games. Rendering often uses 3D accelerators.

The mathematical (vector) spatial model at the stage of rendering turns into a flat picture. If you need to create a movie, then the sequence of these pictures is rendered, one for each frame. As a data structure, the image on the screen is represented by a matrix of points, where each point is determined by at least three numbers: the intensity of blue, red and green. Rendering thus converts a three-dimensional vector data structure into a flat pixel matrix. This step most often requires complex calculations, especially if you need to create the illusion of reality. The simplest type of rendering is the construction of model outlines on a computer screen using projection. Usually this is not enough and it is necessary to form the illusion of the materials from which the objects are made, and the distortions of these objects due to transparent media (for example, liquid in a glass) are calculated. Tracing each ray of light in a scene is impractical and takes a long time. Even tracing a small number of rays, sufficient to obtain an image, takes a large amount of time if approximation (sampling) is not used. They developed several methods that are more effective than modeling all the rays of light that illuminate the scene. There are several rendering technologies that are most often combined (Kozlova, 2013).

Rasterization and the method of scanning lines (English scanline rendering). Visualization is carried out by projecting scene objects onto the screen without considering the effect of perspective on the observer. When applying the line scanning method, the color of each point of the picture is calculated by constructing the ray from the observer's point of view through an imaginary hole in the screen at the place of this pixel "into the scene" until it intersects with the first surface. The color of the pixel will be the same as the color of the given surface. Visualization is carried out by projecting scene objects onto the screen without considering the effect of perspective regarding the observer. Ray casting method. The scene is viewed from a specific point. Rays are directed from the observation point to the scene objects, with the help of which the pixel color will

be determined on a two-dimensional screen. In this case, the rays cease their propagation (in contrast to the backtracking method) when they reach any object. Raytracing is the same as ray-tracking, but the color of a pixel is refined by constructing additional rays (refracted, reflected, etc.) from the point of intersection of the line of sight. The method is like the ray casting method. Rays are directed from the observation point to the objects of the scene, with the help of which the pixel color is determined on a two-dimensional screen. But at the same time, the beam does not stop propagating, but is divided into three components, the beam, each of which contributes to the pixel color on a two-dimensional screen: shadow, reflected and refracted. The number of these component divisions is determined by the depth of the trace and influences photorealism and image quality. Thanks to its own conceptual specifications, the method allows to acquire very realistic images, but at the same time it is quite resource-intensive and the visualization process takes significant periods of time.

Global illumination (Eng. Global illumination, radiosity) is a calculation of the interaction of surfaces and media in the visible spectrum of radiation using integral equations. It uses finite element mathematics to simulate the diffuse propagation of light from surfaces while achieving “soft” lighting effects. Existing software can apply several algorithms to obtain the final image.

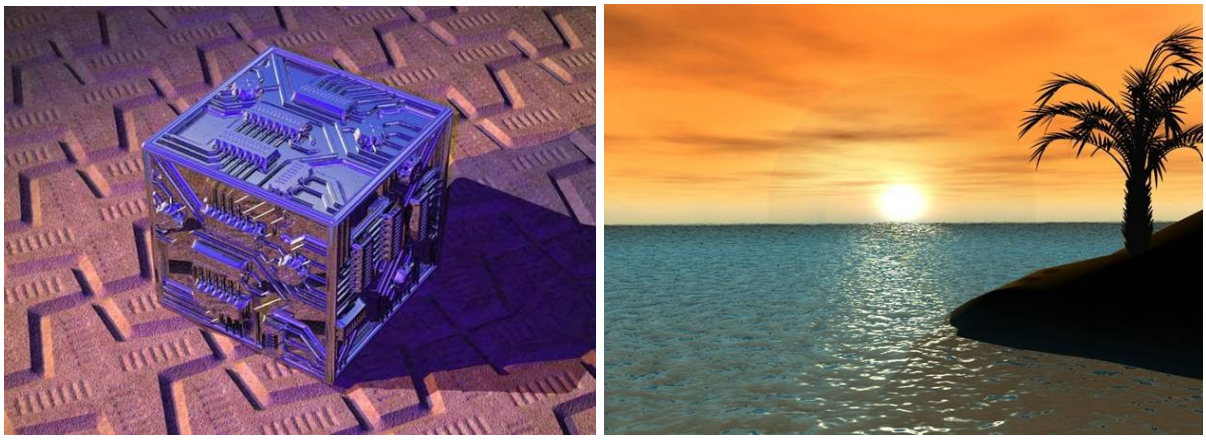

Fig. 1. Examples of different approaches to three-dimensional graphics

The objects of the real world in their form are divided into complex and simple. An example of a simple object is a brick, and a complex object is a car. For any object of the real world, regardless of its nature and complexity, it is possible to form a three-dimensional model. There are different methods of three-dimensional modeling: spline modeling; primitive modeling; the use of modifiers; modeling using editable surfaces: Editable Poly (Editable Polygonal Surface), Editable Mesh (Editable Surface), Editable Patch (Editable Patch - Surface): creating objects using Boolean operations; creating three-dimensional scenes using particles; NURBS– modeling (modeling based on heterogeneous irrational B-splines) (Budanova, 2009). When creating an object on the stage, it is necessary to consider the specifics of its geometry. As a rule, the same object can be modeled by several methods, but there is always a way that is very convenient and takes less time. You cannot create photorealistic objects (high-poly objects), since they require a lot of computer resources on which the final program will be launched, and the more objects on the stage, the greater the load on the graphics engine. When working on three-dimensional objects for interactive systems, it is necessary to take into account these limitations and you need to create objects that are as optimized as possible, but not

at the expense of the quality of the appearance. The balance between optimal complexity and quality is one of the main problems in the formation of objects for interactive systems. Let us present a fragment of the Explanatory Note to the program “3D - modeling”. This program is intended for students aged 10-14. It is aimed at the formation of students' methodological qualities - the ability to set a goal and organize its achievement, as well as creative qualities - inspiration, flexibility of mind, criticality, the presence of one’s opinion, communicative qualities, due to the need to interact with other people, with objects of the world and perceive its information.

During the study of computer technology, the school children can acquire the following abilities:

- use various methods of search, collection, processing, analysis, organization, transfer and interpretation of information;

- prepare presentation and speak with audio–, video– and graphic accompaniment;
- comply with the rules of information selectivity, ethics and etiquette.

The goal is the formation and development of students' intellectual and practical competencies in the field of creating spatial models, the development of elements of the basic pre-professional skills of a specialist in three-dimensional modelling. To achieve this goal, it is necessary to solve the following tasks:

- to form a positive attitude towards three-dimensional modelling algorithms;
- to form an idea of the main software tools for 3D modelling, form skills:
- to navigate in the three-dimensional space of the scene;
- to effectively use the basic tools for creating objects;
- to modify, modify and edit objects or their individual elements.
- to combine created objects into functional groups;
- to create simple three-dimensional models and print them on a 3d printer or simulate them using a 3d pen.

Form of organization: Classes are held 2 times a week for a month. Total 10 hours. Preparation for the lesson involves the search for the necessary missing information in encyclopedias, reference books, books, on electronic media, on the Internet, the media, etc. Adults can also be the source of the necessary information: parents, enthusiastic people, as well as older students.

COURSE CONTENT

Topic 1. Introducing TinkerCAD. We study the location of the TinkerCAD program panels, and the basic techniques for working with the finished scene (viewing modes, rendering, viewing animations).

Topic 2. The simplest objects (primitives). 3D-primitives (cube, sphere, cylinder, etc.) and methods for their movement, rotation, scaling, and cloning are considered.

Topic 3. Transformation of objects. Scaling, moving, mirroring.

Theme 4. The study of logical (Boolean operations) We study the grouping and association of figures, intersection, exclusion.

Topic 5. Creation of a complex architectural object. Securing material covered in difficult scenes

Theme 6. Project implementation. During 4 classes, students complete a project on a selected topic. Printing an object. In the last lesson, students discuss all the work done at the conference.

The planned results of the development of the program create the following areas:

the creation of universal educational activities (regulatory, communicative, personal, cognitive), educational and user-wide ICT - students' competence, experience in design and research, experience with information. Personal results:

- the ability and willingness of students to develop themselves;
- self-assessment based on the conditions for the success of this activity;
- motivation of activity;
- skills of cooperation in various situations, the ability not to create conflicts and ways out of controversial situations;
- ethical feelings, primarily emotional - moral responsiveness and goodwill.

Meta-subject outcomes: Regulatory universal training activities:

- the development of methods for solving problems of a creative nature in life situations;
- the formation of skills to set a goal - the formation of creative work, plan to achieve this goal, create visual dynamic graphic objects in the process of work;
- evaluation of the resulting creative product and its correlation with the original intent, execution, if necessary, of correction of either the product or the intent.

Cognitive universal learning activities:

- build reasoning from general laws to particular phenomena and from particular phenomena to general laws, build reasoning based on comparisons of phenomena and objects, while emphasizing common features.

Communicative universal learning activities:

- the formation and development of competence in the use of information and communication technologies;
- Preparation of graphic materials for effective performance.

Subject results: The course contributes to the achievement by students of the subject results of the subject "Computer Science". The student will receive in-depth knowledge about the possibilities of building three-dimensional models. He will learn to independently create simple models of real objects. To achieve the planned results will help pedagogical technologies using active learning methods. Examples of such technologies are gaming technologies. The educational effect is achieved at two levels of interaction - the student's connection with his teacher and the students interact with each other at the group level. Students are acquiring:

- knowledge of computer science as a part of universal human culture, as a form of description and a method of cognition of reality, of the importance of geometry in the development of civilization and modern society;
- knowledge of how to independently search, find and process information;
- knowledge of the rules of constructive group work; speech culture skills.

In conclusion, we note that additional education is a step into the future not only of the student, but also of the entire educational system.

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