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IMPROVING THE EFFECTIVENESS OF USING 3D MODELING TECHNOLOGIES IN TEACHING ENGINEERING GRAPHICS

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Abstract. The article examines the theoretical foundations, didactic potential and practical effectiveness of 3D modeling (CAD) technologies in teaching engineering graphics at pedagogical universities. It substantiates the combination of traditional drawing methods with modern digital tools and proposes a four-stage methodological model for developing students' spatial thinking and graphic competence.
Keywords: Engineering Graphics, 3D Modeling, CAD, Spatial Thinking, Graphic Competence, Design, Digital Education.

MUHANDISLIK GRAFIKASI FANINI ÖQITIŞDA 3D MODELLAŞTIRIŞ TEXNOLOGIYALARIDAN FOYDALANIŞ SAMARADORLIGINI OŞIRIŞ

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Annotatsiya. Maqolada oliy pedagogik ta'lim muassasalarida muhandislik grafikasi fanini öqitişda 3D modellaştiriş (CAD) texnologiyalaridan foydalanişning nazariy asoslari, didaktik imkoniyatlari va amaliy samaradorligi yoritilgan. An'anaviy çizmaçilik usullari bilan zamonaviy raqamli vositalarning özaro uyğunligi asoslab berilib, talabalarning fazoviy tasavvuri va grafik kompetensiyasini rivojlantirişga qaratilgan tört bosqiçli metodik model taklif etilgan. Modelni ta'lim jarayoniga joriy etiş öquv materialini özlaştiriş sifatini va bölajak öqituvçilarning kasbiy tayyorgarligini oşirişi körsatilgan.
Kalit sözlar: *muhandislik grafikasi, 3D modellaştiriş, CAD, fazoviy tasavvur, grafik kompetensiya, dizayn, raqamli ta'lim.*

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Today, it has become one of the priority areas of the state education policy, which has digitized the education system, adapted the quality of training personnel to international requirements and developed professional competencies of specialists to be trained [1]. In this process, the science of engineering graphics holds a special distinction as one of the main disciplines of technical thinking, spatial imagination and design culture. The importance of this discipline is especially high when training uçun öqituvçi personnel in çizmaçılık and fine arts, technological education and design developments, çölük öqituvçi öz öquvçısını çızmaçıqış, öqiş, analyze and yışni örgatişi uçun must first of all bölişişi who perfectly occupy şu köniks [2]. Therefore, the relevance of the study is determined by the need for future teachers not only to know the rules of drawing, but also to effectively use modern digital design tools in the educational process. The purpose of the article is to determine the pedagogical shart-şaroit of the use of 3D modelaştiriş technologies in öqitiş engineering graphics science, to analyze their impact on students ' graphic training in theoretical and practical terms, and to işlab çiqiş, a methodical model based on şu.

The methodology of engineering graphics etching has a long history, and its theoretical foundation lies in the geometry of drawing. Methods for describing an object in the plane by orthogonal projections are G. After being systematized by Monj, this approach has been the mainstay of technical education for several centuries [3]. Later, Russian and Uzbek scientists developed the content, teaching methods, and textbook system of descriptive geometry and drawing [2], [4]. During the years of independence, the scientific and pedagogical studies of the çizmaçilik öqitiş methodology böyiça köplab were carried out in our republic, the main focus of which was on the graphic literacy of students, the excitation of the çizmaş and the şaklıriş of the doş köplaş köplaş [2], [4], [5]. In recent years, however, the focus of research has changed significantly: now the issues of integrating CAD systems into the educational process, developing spatial thinking through the tools of computer graphics and improving students ' digital competencies have shifted to the center of scientific discussion [6], [7]. In foreign studies, however, in engineering education, there is a justification that the spatial imagination can develop the pattern and it through special tasks [8], [9], [10]. In most of these studies, it is noted that the 3D modeling of the principle of visual visualization, the study of the student's independent processing and creative combustion engineering [11]. Along with Şu, some authors argue that relying solely on the program can lead to the silencing of çiziş bricks in qöl, mechanical memorization of commands, and non-fulfillment of the essence of çizma rules. Therefore, the scientific solution to the problem lies not in replacing one traditional and digital method with another, but in combining them into a complementary integrated system.

The theoretical basis of the study is the development of spatial imagination and the development of graphic competence. Spatial imagination refers to the ability to visualize the shape in the mind, to rotate it in space, to visualize the appearance of various shapes, and to measure the axis from the image in the plane to the object with dimensions and to measure the axis. This ability develops in the process of targeted tasks, rather than the acquisition feature, which is considered one of the central tasks of the engineering graphics öqitiş şu uçun şaklış it [9], [10]. Many studies have shown that spatial ability is related to success in STEM fields, including engineering education, and can be developed through special training [12], [13]. While graphic competence is more extensive, it measures the ability to create and transmit technical information using modern software tools [7]. From a pedagogical perspective, the development of graphic competence requires the integration of knowledge, skills, and personal qualities, including responsibility, accuracy, and creativity. In traditional lessons, the student

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often repeats the prepared solution sequence, while in complex forms, he cannot restore spatial relationships in his mind and loses the meaning of the lines in the drawing. 3D modeling eliminates this difficulty: the student rotates the object on the screen, observes its hollow structure through a clipping, and directly visualizes how each chipped blind generates from the model. The didactic capabilities of CAD systems are versatile. First, they raise the level of exhibitionism to a qualitatively new level, because instead of a static drawing, a moving, changeable model is displayed [11]. Second, parametric modeling allows the student to observe how the shape changes when the dimensions are changed, which helps to understand geometric relationships in depth. From the reader, the possibility of quick detection and correction of errors creates an environment of effort and search to test in the process of measurement, the student tries different options, not ignoring the error. From the törtınçı, the automatic generation of bellows, Shears and scales from the finished 3D model reduces the time taken to perform the chisel and allows this time to project thinking, i.e. choosing the shakl, basing the constructive takçim and deleting to design issues. Since systems such as AutoCAD, KOMPAS-3D, SolidWorks, Autodesk Inventor, Fusion 360 are widely shared in practice, the graduate who has customized them will be able to give modern knowledge to both the prepared and the öz Öz öqüçi with market requirements. [14]

Despite the success, the introduction of 3D modeling into the educational process also causes a number of problems. First of all, the issue of the material and technical base: a sufficient number of computers, licensed or educational uçun oçiq software and the timing of the allocation of the uçun uçun is not always available. In addition, the preparation of the students ' correspondence is different, some of them are free to work with the computer, while others spend a lot of time to customize the program interface. Most importantly, if the program is carried out with the rules of örgatiş çizmaçılıq separated from örgatiş, the student will be able to create a model with a wheelbarrow and not formalize it according to the standard. Because of Şu, 3D modeling is not an independent goal, but rather as a tool that serves the main tasks of engineering graphics science, qaraş is necessary, and this qaraş follows the basis of the model offered below.

The proposed methodological model consists of a tört bosiç bölib, with each bosiç logically continuing its predecessor and didactically relying on the principles of invisibility, sequence, activity, and the relationship of theory with Practice [2], [14]. Birinçi bosiç tökilç is attached to the strengthening of knowledge: students perform projection methods, basic bellows, cuts and cuts in böyiça qöl, since it is şu maşqlar who creates the foundation of graphic thinking and prepares a conscious humanizing uçun floor of the software tools in the next bosiç. In binary bosiç, the student obtains the creation of a 3D model: initially simple geometric bodies, namely prism, cylinder and cone, söngra are modeled with more complex details, in which basic commands such as extrusion, rotation, bulev actions and shearing are visualized through specific didactic tasks. In the Uçinçi bosiç, the çizma şaklış from the finished model, which takes the basic bellows, cuts, measurements and technical requirements into measurements, the student analyzes the differences and the causes of errors, solidifying the result of the crop Balgan with the çizma performed in the mold; this bosiç is the one that binds the two methods to a holistic system. In törtınçi bosiç, the student performs an independent project and design search: öquv çıqadışışışışışı gun, machete or maişıy product project, visualizes it, formalizes its drawing and protects it in front of the team. Şuşa student becomes şaxş, who is able to base the project on the creator and the Öz yeçim from the recipient of knowledge, which is especially important in bölacaq öqituvçi uçun.

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The study used theoretical analysis of literature, pedagogical observation, survey and testing, pedagogical pilot testing, and statistical processing of results. The experiment-test was conducted on the basis of a methodology enriched with elements of 3D modeling in the experimental group, on the basis of a methodology enriched with elements of 3D modeling, on the basis of a traditional method in the control group of undergraduate students of the Urganç State Pedagogical Institute of Fine Arts and engineering graphics. The analysis of the spatial imagination level in the experimental vessel was carried out in the test, which determined the level of spatial imagination in the experimental vessel [9], [10], with the same program, the same clock size and the same control findings stored in the söng differ only in the measurement methodology.

When discussing the results, it is first necessary to determine the difference in the indicators of the experimental and control groups and its causes. Theoretical analysis and pedagogical observations show that 3D modeling produces the highest degree of spatial imagination from a student [9], [11]. The model allows the student to see the internal structure of the text, understand the relationship between the parts, and immediately identify errors, thereby increasing their interest in the subject. However, during the experiment, problems such as difficulties in the connection with the software, the tightness of the computer rooms and the lack of time were also observed; they can be reduced through the use of educational uçun free programs and the use of independent Iş in remote şaklda taşkil etiş. It is also emphasized that çiziş bricks should also be stored in qöl, since they remain the basis of spatial thinking and provide professional activity even in situations where it is not possible to use the program. Hence, it is the most optimal fiber that adapts traditional and digital methods.

In conclusion, 3D modeling technologies in the study of engineering graphics are an effective means of developing the spatial imagination and graphic competence of students. The proposed tört bosiçli model serves the öquv material çuqur özlaştiriş by providing izçil ötiş from çiziş to 3D modellaştiriş, from it to çizma şaklıştiriş and finally to independent design. When preparing future öqituvçılar CAD programs örgatiş takes their professional training and digital literacy, öz in turn improves the quality of providing modern graphic knowledge to future school öquvçılar. Continuing the research in the future, it is advisable to introduce the technologies of augmented reality (AR/VR) and 3D printing çiqariş into the educational process, as well as the artificial intelligence tools örnini örganiş in graphic education [15].

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