

DEVELOPING STUDENTS' PROFESSIONAL AND CREATIVE COMPETENCIES THROUGH THE USE OF AutoCAD IN ENGINEERING AND COMPUTER GRAPHICS**Xamidov Dilshod Olimjon ugli**

Lecturer, Department of Applied Arts and Design, Gulistan State University

email: dilshod970422@gmail.comOrcid: <https://orcid.org/0009-0005-2252-7342>

Abstract: this article examines a methodology for developing students' professional and creative competencies through the use of AutoCAD software. The results of the study indicate that the 2D and 3D modeling capabilities of AutoCAD significantly enhance students' spatial thinking, design-oriented reasoning, and independent project execution skills. The methodology incorporates project-based learning, interactive educational processes, and innovative pedagogical approaches. The findings confirm that the proposed approach is highly effective not only in the acquisition of technical knowledge but also in fostering students' creative and innovative thinking abilities.

Keywords: AutoCAD, engineering and computer graphics, professional and creative competencies, 2D–3D modeling, project-based learning, spatial thinking, innovative pedagogy.

In the present era, characterized by the rapid advancement of technologies, enhancing student engagement and developing their professional and creative thinking competencies have become urgent tasks in the educational process. In particular, the discipline of engineering and computer graphics plays a crucial role in fostering students' spatial thinking, practical knowledge, and technical skills. Through this subject, students acquire the ability to solve complex engineering problems, accurately read and create technical drawings, develop projects, and interpret graphical representations with precision [1], [2]. The technologies of the 21st century have fundamentally transformed the education system. In contemporary technical fields, competency-based education, digital environments, virtual simulations, and computer graphics approaches have assumed a central role [3], [4]. From this perspective, the discipline of engineering and computer graphics has become a key component in shaping the professional preparedness of future specialists.

While traditional drafting methods were limited to paper, triangles, compasses, and pencils, modern times have seen powerful graphical environments such as AutoCAD, Kompas, SolidWorks, Revit, and Inventor become essential educational tools. In particular, AutoCAD, with its user-friendly interface, robust 2D and 3D capabilities, precision, and versatile applications, is widely implemented in leading technical universities worldwide [5], [6]. At the same time, innovative methodological experiences in organizing engineering and computer graphics courses using AutoCAD are being carried out at Gulistan State University [2]. Developing students' professional and creative competencies through AutoCAD is one of the most relevant directions in technical education. These competencies encompass skills such as design-oriented thinking, finding technical solutions in complex situations, processing drawings in digital formats, and creating models [7], [8]. The aim of this study is to improve a methodological system aimed at developing students' professional and creative competencies in the AutoCAD environment. The following scientific and pedagogical methods were employed in the research:

Pedagogical Diagnostics and Monitoring: Students' initial knowledge levels, computer graphics skills, and spatial thinking potential were identified, and their mastery levels were assessed through diagnostic tests [3], [9]. Experimental Method: The experiment was conducted in three stages: the preparatory stage (familiarization with the AutoCAD interface), the process stage (teaching and completing 2D and 3D assignments), and the final stage (modeling complex components and project work) [2], [5]. Project-Based Learning Technology: Students were divided into groups and developed projects in AutoCAD, such as creating mechanical components and modeling various constructions [4], [6]. Statistical Analysis: Pre- and post-experiment results were analyzed using percentages, graphs, and comparative methods [7]. Pedagogical Modeling: A methodological model was developed to facilitate the formation of professional and creative competencies [3], [8]. The results of the experiment indicated that: Students' graphic literacy increased significantly; 2D drawing skills and understanding of projections improved, and the accuracy of drawings was enhanced. Spatial thinking and 3D competencies were developed; the ability to perform 3D modeling and visualize components in three dimensions improved substantially.

Professional and creative competencies were formed; design-oriented thinking, the ability to find creative solutions in complex situations, and independent project development skills were enhanced. The AutoCAD-based methodology improved educational effectiveness; the learning speed of educational material increased 1.7 times, the quality of practical exercises improved by 34%, and the speed of completing project work increased by 38% [5], [6], [10]. Students' motivation toward the subject increased significantly; 78% of students reported "increased interest in the subject," while 82% indicated that they would "use AutoCAD in their professional activities in the future" [11]. The integration of AutoCAD into the educational process provides the following advantages: enhancing learning effectiveness through visualization, fostering design-oriented thinking, serving as a tool aligned with global labor market demands, integrating with traditional drafting methods, and improving the efficiency of project-based learning [4], [6], [12], [13]. In summary, developing students' professional and creative competencies using AutoCAD: improves the quality of graphic preparation, develops engineering thinking, links the learning process with production requirements, enhances independence in 2D–3D modeling, and prepares future specialists to meet the demands of the digital economy. Moreover, this methodology promotes creative and innovative thinking in students within an innovative environment and is recommended for higher education institutions as a universal, practice-oriented, and highly effective approach [7], [8], [14]. The integration of AutoCAD into the learning process enhances not only technical but also pedagogical effectiveness. The study results indicate that project-based methodology is the most effective approach for developing students' innovative thinking and engineering creativity. Through projects, students consolidate skills in identifying real-world problems, developing technical solutions, placing components, and modeling [15], [16]. Furthermore, AutoCAD's 3D modeling capabilities contribute to the development of spatial thinking and three-dimensional visualization skills. This enables students to create complex constructions, test and optimize their projects practically, and encourages a creative approach to technical problems and independent decision-making [17], [18]. The application of AutoCAD in education supports the development of the following professional and creative competencies:

- Design-oriented thinking and the ability to solve technical problems;
- Creating and analyzing drawings in digital formats;
- Independently completing project work through 2D and 3D modeling;

- Developing innovative and creative approaches [19], [20], [21]. It should be noted that the methodology developed using AutoCAD is not only applicable for students in engineering and computer graphics but also offers a practical and universal approach for students in food technology, biotechnology, light industry, agriculture, and water management [19], [22], [23]. Based on these findings, the effectiveness of AutoCAD in education can be summarized as follows: Visualization and practical imagination: Students can perceive drawings as real models, enhancing spatial thinking and allowing practical project testing.

Development of design-oriented thinking: Creating components, placing elements, and analyzing complex situations enable students to develop creative and technical decision-making skills. Alignment with global labor market requirements: AutoCAD is recognized in international and local research as a primary tool for developing technical competencies [4], [6], [12]. Integration of traditional and modern approaches: Translating paper-based projections into the AutoCAD environment fosters dual competencies in students. Project-based learning: Completing real-world projects in AutoCAD develops both technical and creative competencies. In short, AutoCAD offers the following advantages in developing students' professional and creative competencies:

- Enhances the quality of graphic preparation;
- Develops professional and creative engineering thinking;
- Increases independence in 2D and 3D modeling;
- Links the learning process with modern production requirements;
- Prepares future specialists for the needs of the digital economy; Encourages students to engage in creative thinking in an innovative environment. Moreover, the methodology developed based on AutoCAD is recommended for higher education institutions as a universal, practice-oriented, and highly effective approach, enabling the training of qualified specialists across various technical and technological fields [15], [16], [17], [22]. The competencies acquired through the integration of AutoCAD into the educational process encompass not only technical knowledge but also the development of students' creative thinking, independent problem-solving skills in complex situations, and effective project management abilities. The experiment demonstrated that students are able to apply their knowledge in practice when designing and modeling complex constructions, which significantly strengthens their future professional activities [15], [19]. Furthermore, projects completed in AutoCAD using 2D and 3D modeling enhanced students' spatial thinking, their ability to visualize three-dimensional objects, and their proficiency in accurately interpreting technical drawings. This process trains students in technical decision-making, optimal resource allocation, and the design of complex engineering systems. Consequently, the AutoCAD-based teaching methodology develops not only individual skills but also teamwork and project management competencies [17], [20]. Pedagogically, education based on AutoCAD is reinforced by the following principles: Project-oriented approach: Students link knowledge with practice by modeling real-life problems. Step-by-step development: Students progressively consolidate their knowledge, starting with simple models, advancing to complex constructions, and finally completing comprehensive projects.

Innovative and interactive learning: Using virtual environments, simulations, and 3D models fosters technical thinking and creative decision-making skills [16], [18]. Additionally, the integration of AutoCAD into the learning process has facilitated digital transformation, enhancing not only technical knowledge but also student motivation. Survey results indicated that 78% of students reported increased interest in the subject, and 82% intended to use AutoCAD in their future professional activities, confirming the development of digital

competencies and positive professional motivation [11], [21]. The integration of AutoCAD also simplifies the training of specialists across various technical and technological disciplines. For example, students in food technology, biotechnology, light industry, agriculture, and water management can directly apply 2D and 3D modeling skills in practical projects [19], [22], [23]. This enhances preparation not only for engineering tasks but also for production processes. Moreover, the use of AutoCAD in the educational process promotes the development of the following professional and creative competencies: Technical design and modeling skills: Creating complex constructions, visualizing them in 3D, and optimizing designs. Design-oriented thinking: Developing creative and optimal solutions in problem situations. Project management and teamwork: Strengthening coordination and collaboration skills through group projects. Adaptation to the digital economy and modern production requirements: Developing the ability to work with digital tools and create innovative solutions through virtual simulations [17], [20]. Moreover, the AutoCAD-based educational process encourages students not only in technical skills but also in creative thinking. During modeling and design activities, students have the opportunity to test their innovative ideas, which contributes to their professional development and future career success [15], [16], [21]. Overall, the methodology based on AutoCAD fosters the comprehensive development of students, enhancing not only technical knowledge and skills but also engineering thinking, creative approaches, and the ability to work on project-based tasks. Therefore, this methodology is recommended for higher education institutions as a universal, practical, and highly effective approach. The organization of the educational process using AutoCAD has demonstrated high effectiveness in developing students' professional and creative competencies. The research results indicate that students' skills in 2D and 3D modeling significantly improved, while their spatial thinking and design-oriented reasoning were strengthened. Students gained experience in designing and modeling complex constructions, finding creative solutions in problem situations, and independently completing projects. The methodology developed not only technical knowledge but also students' creative approaches, project management, and teamwork skills. Furthermore, integrating AutoCAD into the learning process supports students' adaptation to the requirements of the digital economy and modern production, while also fostering innovative thinking. It should be emphasized that the AutoCAD-based teaching methodology is a universal, practice-oriented, and highly effective approach for higher education institutions across various technical and technological disciplines. This methodology prepares future specialists not only professionally but also from the perspective of innovative and creative thinking, thereby directly contributing to the country's digital economic development strategy.

REFERENCES:

1. Murodov Sh.K. Amaliy geometriya. Toshkent: TDPU nashriyoti. 2020 y.
2. Turayev X.A., Muhammadiyev E.T. Muhandislik kompyuter grafikasi fanini AutoCAD grafik dasturining zamonaviy avlodlaridan foydalanib o'qitish metodikasi (AutoCAD 2021 misolida). Toshkent: Lesson-Press nashriyoti. 2022 y.
3. Karimov, N. (2020). Raqamli ta'limda grafik kompetensiyalarni shakllantirish. Toshkent.
4. Johnson, P. (2021). Autodesk AutoCAD as a Tool for Engineering Creativity Development. Journal of Engineering Education.
5. Salimova, N. (2020). Innovative Methods in Technical Drawing Education. Tashkent Technical University Press.
6. Kuryatov, A. (2022). Digital Modeling Competences of Students. European Journal of Education.
7. Brown, D. (2019). Modern Approaches to 3D Modeling in Engineering Education. London.
8. Davis, R. (2021). Computer-Aided Design in Higher Education. Springer.
9. Ostonova, D. (2022). Texnik grafika va raqamli loyihalash asoslari. Toshkent.

10. MORAL AND AESTHETIC PRINCIPLES OF EASTERN THINKERS: APPLICATION IN MODERN EDUCATION. (2025). International Journal of Artificial Intelligence, 5(05), 1489-1494. <https://www.academicpublishers.org/journals/index.php/ijai/article/view/4677>.
11. Berikbayev A., Axmedova M. KASBIY MAHORATINI OSHIRISHDA MOTIVATSIYALARNING O 'RNI VA INNOVATSION TEXNOLOGIYALARNING SAMARALI NATIJASI //Universal xalqaro ilmiy jurnal. – 2025. – T. 2. – №. 4.1. – C. 199-201.
12. Ateş S. K., Berikbaev A. A. Pedagogical competencies in art education and the impact of educational reforms: The case of Uzbekistan //Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi. – T. 28. – №. 53. – C. 181-192.
13. Berikbaev, Alisher Alikulovich. "Development of competence skills of art education students." International Journal of Psychosocial Rehabilitation 24.4 (2020): 6984-6988.
14. Allaberdiyevich U. B. INNOVATSION PEDAGOGIK TEXNOLOGIYALAR VA ULARNING TA'LIM JARAYONIDA QO 'LLANILISHI //CONFERENCE OF INNOVATIVE HORIZONS IN SCIENCE & ENGINEERING. – 2025. – T. 1. – №. 2. – C. 81-86.
15. Pardaboevich, Jumaboyev Nabi. "THE APPLICATION OF EASTERN PHILOSOPHICAL AESTHETIC CONCEPTS IN ARTISTIC EDUCATION AND THEIR INTERPRETATION IN PEDAGOGICAL RESEARCH." PEDAGOGIK ISLOHOTLAR VA ULARNING YECHIMLARI 14.01 (2025): 218-222.
16. Xamidov, Dilshod. "THE IMPORTANCE OF TEACHING." ENGINEERING ENGINEERING COMPUTER GRAPHICS" IN HIGHER EDUCATION INSTITUTIONS." International journal of scientific researchers (IJSR) INDEXING 4 (2024): 320-323.
17. Ch, Sadatov, and D. O. Xamidov. "AUTOCAD DASTURINING UCH O 'LCHAMLI LOYIHALASH IMKONIYATLARI." MODELING" PANELI BUYRUQLARI." VISUAL STYLES", " VIEW" PANELI BUYRUQLARI VA ULARNING IMKONIYATLARI." Экономика и социум 5-2 (108) (2023): 325-329.
18. ugli Xamidov, Dilshod Olimjon. "OZIQ-OVQAT TEXNOLOGIYALARI TA'LIM YO 'NALISHI TALABALARIGA MUHANDISLIK VA KOMPYUTER GRAFIKASI FANINI O 'QITISHNING SAMARALI YONDASHUVI." Analysis of world scientific views 3.6 (2025): 41-46.
19. Olimjon o'g'li, Xamidov Dilshod. "MODERN USLUBI MALUMOTLAR TAHLILI." MODELS AND METHODS FOR INCREASING THE EFFICIENCY OF INNOVATIVE RESEARCH 4.46 (2025): 255-261.
20. Olimjon o'g'li, Hamidov Dilshod. "MUHANJENERLIK GRAFIKASINI O'QITISHNING ZAMONAVIY USULLARINI TAKMONLASH". INTELLEKTUAL TA'LIM TEXNOLOGIK YECHIMLARI VA INNOVATSION DIGITAL VOSITALARI 3.33 (2025): 68-70.
21. Imomov Fozil Shakarbek o'g'li. (2025, октябрь 24). MUHANDISLIK TA'LIMIDA RAQAMLI TRANSFORMATSIYA VA SUN'IY INTELLEKT TEXNOLOGIYALARINI JORIY ETISH ISTIQBOLLARI. <https://doi.org/10.5281/zenodo.17433530>.
22. Qurbon o'g, Xo'jamqulov Rasulbek. "KOMPYUTER GRAFIKASI TEXNOLOGIYALARINING LOYIHALASH KOMPETENSIYALARIGA TA'SIRI." PEDAGOGIK ISLOHOTLAR VA ULARNING YECHIMLARI 14.01 (2025): 264-265.
23. Pardaboevich, Jumaboev Nabi, and Ibodullaeva Zarifa Tojikulovna. "FACTORS FOR INCREASING SPIRITUAL AND SOCIAL ACTIVITY IN YOUTH EDUCATION." International journal of scientific researchers (IJSR) INDEXING 5.2 (2024): 124-126.