



METHODOLOGY FOR TEACHING ENGINEERING GRAPHICS IN HIGHER EDUCATION THROUGH INNOVATIVE EDUCATIONAL TECHNOLOGIES

Abdurakhimov Lola Khursanovich

Associate Professor, Department of Fine Arts
Termez State Pedagogical Institute

Mirzabekova Yulduz Fazliddin qizi

First-year Master's student at the Faculty of Engineering
Graphics and Design Theory
Termez State Pedagogical Institute

Abstract. *This article presents a scientific and theoretical analysis of the methodology for teaching Engineering Graphics in higher education based on innovative educational technologies. It substantiates the advantages of integrating digital learning platforms, ICT tools, CAD systems (AutoCAD, SolidWorks, Inventor), AR/VR resources, interactive teaching methods, and task-based learning technologies into the teaching of Engineering Graphics. The paper highlights effective methodological approaches aimed at developing students' graphic literacy, spatial imagination, creative and critical thinking, problem-solving abilities, and professional competencies. In addition, the article provides recommendations on enhancing teaching quality, organizing interactive learning environments, shifting the educational process towards a learner-centered approach, and improving students' employability through the integration of innovative technologies into the teaching and learning process.*

Keywords: *engineering graphics, innovative educational technologies, higher education, interactive methods, ICT, CAD systems, AutoCAD, digital pedagogy, visual learning, spatial thinking, creative thinking, competency-based approach, task-based learning, AR/VR technologies, engineering education.*

Introduction. Teaching Engineering Graphics in the higher education system plays a fundamental role in developing the professional competencies of future engineers, architects, designers, and technical specialists [3, 5]. In the context of the

digital economy, graphic literacy, spatial imagination, projection-based thinking, and the ability to read and create technical drawings are considered essential indicators of learning outcomes. Therefore, designing and implementing a methodology for teaching Engineering Graphics based on innovative educational technologies is crucial for ensuring quality, effectiveness, and labor-market-oriented training in higher education [1, 4].

Innovative approaches shift the educational process towards a learner-centered model through the integration of interactive teaching methods, ICT tools, and task-based as well as project-based learning concepts. In this regard, CAD systems such as AutoCAD/AutoCAD LT and SolidWorks/Inventor, along with collaborative platforms such as Jamboard, AR/VR elements, simulation and visualization tools, as well as a well-designed LMS environment (online assessments, rubrics, e-portfolios), serve as integral components of the didactic system [2].

This methodology aims to:

- integrate theory with practice through authentic industry-based tasks;
- foster interactive learning environments that develop collaboration, analytical and creative problem-solving skills;
- strengthen digital design competencies through CAD-based 2D/3D modeling;
- implement transparent formative and summative assessment based on rubrics, checklists, mini-projects, and e-portfolios;
- ensure inclusiveness and differentiated learning opportunities;
- enhance university-industry cooperation for practice-oriented learning.

This methodology aims to:

1. Theory-Practice Integration:

Integrating theoretical knowledge with industry-oriented practical tasks, mini-projects, and modeling activities to develop students' working drawing culture and professional competencies.

Theory-practice integration is a methodological approach aimed at combining theoretical concepts with authentic industry-related tasks, mini-projects, digital modeling, and design activities in the teaching of Engineering Graphics. This approach enhances students' working drawing literacy, graphic proficiency, and professional skills by aligning the content, structure, and outcomes of learning with labor market requirements.

Within this approach, theoretical concepts (such as projection, systems of views, sections and cuts, dimensioning, tolerancing, surface quality, and drawing standardization) are deeply assimilated through their application in practical design projects. During the learning process, students acquire not only academic knowledge, but also technical thinking, design culture, justification of engineering solutions, and the ability to work with regulatory documentation (GOST/ISO/UzDSt) required in industrial practice.

Overall, theory–practice integration in the teaching of Engineering Graphics aims not at simple drawing execution, but at forming a professional, practice-oriented technological mindset that includes design, modeling, technical reasoning, and industry-focused application. This ensures that graduates possess practical competencies aligned with labor market demands.

2. Interactive Environment Competencies:

Developing skills in teamwork, problem analysis, and generating creative solutions through interactive teaching methods (case studies, brainstorming, design sprints, debates).

Interactive environment competencies represent an instructional strategy aimed at fostering students' ability to collaborate effectively in teams, analyze problem situations, justify diverse viewpoints, and generate creative solutions. The use of interactive methods in teaching Engineering Graphics activates students' cognitive engagement, structures the learning process around dialogue and collaboration, and shifts the educational experience from passive “memorization” to active “application, creation, and innovation”.

The primary purpose of this approach is to establish a learner-centered instructional model in which students are not merely consumers of knowledge, but active creators, analysts, and solution developers. This aligns fully with the “21st-century skills” framework required in modern engineering, design, and technical education-communication, collaboration, creativity, and critical thinking (4C).

3. Digital Design Competencies:

Enhancing students’ practical skills in creating, reading, analyzing, and editing 2D/3D drawings through the use of CAD and digital modeling tools.

Digital design competencies represent a set of skills aimed at enabling students to work with modern CAD (Computer-Aided Design) systems and digital modeling tools for the creation, interpretation, analysis, modification, standardization, and industrial adaptation of 2D/3D drawings. This direction ensures that students acquire Engineering Graphics not only as a traditional graphical discipline, but as an area integrated with contemporary digital design technologies. Developing digital design competencies requires the instructor to purposefully integrate technological tools into the learning process, while students are expected to demonstrate creativity, technological thinking, and constructive reasoning. As a result, students develop the ability to independently design, analyze, and prepare technical documentation in a digital environment, shaping them into specialists capable of working with modern engineering design technologies.

4. Systematization of Assessment:

Implementing transparent and measurable formative (process-based) and summative (result-based) assessment through rubrics, checklists, mini-projects, and e-portfolios.

Systematized assessment refers to the integration of formative (ongoing) and summative (final) assessment approaches, administered through rubrics, checklists, mini-projects, and e-portfolios in a transparent, objective, criteria-based, and measurable manner. This approach shifts the focus from merely “assessing knowledge” to “assessing learning and fostering development through assessment”.

This system allows evaluating not only the final product of student work in Engineering Graphics, but also all stages of their learning activity-including planning, inquiry, annotated drawing creation, analysis, error detection, improvement, and project defense-thus promoting continuous growth and reflective learning.

5. Inclusion and Differentiation:

Ensuring equal learning opportunities for students with different levels of preparedness through differentiated tasks, scaffold cards, and supportive learning resources.

Inclusion and differentiation constitute a methodological approach aimed at ensuring equal access to quality education for all students by organizing the learning process based on their individual abilities, levels of preparedness, learning styles, interests, and cognitive needs. In the context of teaching Engineering Graphics, this approach does not imply applying the same methods and tasks to all learners, but rather presenting instructional content in differentiated, adapted, and scaffolded formats.

Inclusive and differentiated instruction supports students within the principle of “achieving success at one’s own level of capability,” enhances their learning motivation, strengthens self-confidence, and helps shape individualized learning trajectories.

6. Industry Integration:

Aligning the content of education with industrial practice through real design briefs, guest experts, internships, and joint industry–university projects.

Industry integration is a pedagogical model aimed at aligning the content of Engineering Graphics education with real industrial environments, labor market requirements, and the development of students’ practical competencies. This approach accelerates the transition “from classroom learning to industrial practice” by linking theoretical components of education with the real needs of industry,

strengthening students' professional adaptability, applied knowledge, and hands-on skills.

The methodological foundation of this approach is built upon constructivism (active knowledge construction), competency-based education (learning outcomes), Kolb's experiential learning cycle (experience–reflection–conceptualization–experiment), and Bloom's taxonomy (from knowledge acquisition to creation). Collectively, these frameworks contribute to the holistic development of students by fostering not only technical knowledge and skills, but also critical thinking, communication, time management, engineering ethics, and elements of design thinking.

Conclusion. In conclusion, teaching Engineering Graphics in higher education based on innovative educational technologies serves as a key factor in the professional development of future engineers, architects, designers, and technical specialists. In the context of the digital economy, the formation of competencies such as graphic literacy, spatial imagination, projection-based thinking, digital design, and industry-oriented technical reasoning has become a crucial indicator of educational quality and graduates' competitiveness in the labor market.

The findings of the study indicate that the implementation of innovative approaches in the teaching of Engineering Graphics enriches the content of the learning process, increases student engagement, and contributes to organizing education in an effective, practice-oriented, and competency-based model.

References:

1. Abduraximov, L. X. (2022). Muhandislik grafikasi va chizma geometriya fanidan talabalar mustaqil ishini tashkil qilish texnologiyasi. *ijtimoiy fanlarda innovasiya onlayn ilmiy jurnali*, 63-66.
2. Abduraximov, L. X. qizi, ASC.(2022). *Muhandislik grafikasi va chizma geometriya fanidan talabalar mustaqil ishini tashkil qilish texnologiyasi. Ijtimoiy fanlarda innovasiya onlayn ilmiy jurnali*, 63–66.

Абдурахимов, Л. Х., Бакирова, Х. Ж., & Абдурахимов, У. Л. (2019). Обучение детей графической деятельностью в средне образовательной школе. *Интернаука*, (47-1), 34-36.

3. Xursanovich, L. A. (2023). Pencil Drawing-Fine Art as A Basis. *American Journal of Research in Humanities and Social Sciences*, 11, 228-231.

4. Xushvaqtoy, S., Turg'Unov, D., & Abduraximov, L. (2023). Elektr yuritmal avtomobillarning strukturaviy tahlili. *Oriental renaissance: Innovative, educational, natural and social sciences*, 3(1-2), 368-372.

5. Tasviriy san'atda qalam tasvirning tutgan o'rni. (2022). *Conferencea* , 75-78.

<https://conferencea.org/index.php/conferences/article/view/619>