

**O‘ZBEKISTON RESPUBLIKASI OLIY TA’LIM, FAN VA
INNOVATSIYALAR VAZIRLIGI**

**MIRZO ULUG‘BEK NOMIDAGI O‘ZBEKISTON MILLIY
UNIVERSITETINING JIZZAX FILIALI**



KOMPYUTER ILMLARI VA MUHANDISLIK TEXNOLOGIYALARI
mavzusidagi Xalqaro ilmiy-texnik anjuman materiallari to‘plami
2026-yil 25-26-sentabr

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Kompyuter ilmlari va muhandislik texnologiyalari. Xalqaro ilmiy-texnik anjuman materiallari to'plami – Jizzax: O'zMU Jizzax filiali, 2026-yil 25-26-sentabr. 507-bet.

Xalqaro miqyosidagi ilmiy-texnik anjuman materiallarida zamonaviy kompyuter ilmlari va muhandislik texnologiyalari sohasidagi innovatsion tadqiqotlar aks etgan.

Globalashuv sharoitida davlatimizni yanada barqaror va jadal sur'atlar bilan rivojlantirish bo'yicha amalga oshirilayotgan islohotlar samarasini yaxshilash sohasidagi ilmiy-tadqiqot ishlariga alohida e'tibor qaratilgan. Zero iqtisodiyotning, ijtimoiy sohalarni qamrab olgan modernizatsiya jarayonlari, hayotning barcha sohalarini liberallashtirishni talab qilmoqda.

Ushbu ilmiy ma'ruza tezislari to'plamida mamlakatimiz va xorijlik turli yo'nalishlarda faoliyat olib borayotgan mutaxassislar, olimlar, professor-o'qituvchilar, ilmiy tadqiqot institutlari va markazlarining ilmiy xodimlari, tadqiqotchilari, magistr va talabalarining ilmiy-tadqiqot ishlari natijalari mujassamlashgan.

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Mazkur to'plamga kiritilgan ma'ruza tezislarining mazmuni, undagi statistik ma'lumotlar va me'yoriy hujjatlarning to'g'riligi hamda tanqidiy fikr-mulohazalar, keltirilgan takliflarga mualliflarning o'zlari mas'uldirlar.

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THEORETICAL AND METHODOLOGICAL FOUNDATIONS FOR DEVELOPING FUTURE ENGINEERS' GRAPHIC COMPETENCE IN A DIGITAL EDUCATIONAL ENVIRONMENT

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Abstract: This paper examines the theoretical and methodological foundations for developing future engineers' graphic competence in a digital educational environment. It synthesizes approaches to graphic training and identifies the educational functions of CAD systems, three-dimensional modeling, visualization, and electronic portfolios. Graphic competence is interpreted as an integrated capacity to understand, create, evaluate, and communicate technical representations. The analysis brings together competency-based, activity-based, systems, person-centered, and integrative approaches within a methodological framework linking content, digital tools, practical activity, and assessment. Professionally oriented tasks, teacher guidance, and reflection are identified as conditions for connecting digital graphic work with engineering practice.

Keywords: digital educational environment, graphic competence, engineering graphics, CAD, 3D modeling, spatial imagination, competency-based approach.

Introduction

Engineering activity involves digital design, automated drawing, three-dimensional modeling, virtual prototyping, and electronic technical documentation. These practices require graduates to interpret spatial relationships, communicate design ideas, and evaluate graphical solutions. Consequently, engineering graphics education should connect drawing principles with purposeful digital activity. Its central pedagogical task is to develop transferable graphic competence rather than proficiency in isolated software commands.

Digital education policy and research place emphasis on accessible resources, appropriate pedagogy, and the educational purpose of technology [1; 2]. A digital educational environment can therefore be understood as an integrated system of electronic resources, CAD tools, virtual laboratories, interactive assignments, and assessment mechanisms. Its value for graphic training depends on how these elements support students' reasoning and independent work. The purpose of this paper is to systematize the theoretical approaches and methodological conditions for

developing graphic competence. The discussion is based on theoretical analysis and synthesis of the literature.

Theoretical foundations of graphic competence

Graphic competence is a future engineer's readiness to read and produce drawings, understand spatial forms, analyze graphic information, develop constructive solutions, and express them using appropriate tools. It combines theoretical knowledge, drawing literacy, spatial imagination, digital skills, and compliance with technical standards. Graphic representations also function as a language of professional communication: their accuracy determines whether dimensions, structures, and design intentions can be interpreted consistently [4; 6; 8].

Spatial imagination connects a technical object, its two-dimensional representation, and its three-dimensional model. Students need to interpret views and sections, mentally transform objects, and reconstruct spatial forms from drawings. Research on spatial ability and visualization provides a basis for treating these operations as explicit learning objectives [3; 4]. Digital models allow learners to rotate objects, compare views, and inspect relationships that may be difficult to infer from a static image. Such visualization should be accompanied by explanation and independent reasoning.

Research on graphic competence links graphic competence with engineering computer graphics, interdisciplinary learning, and visual thinking. Ashirbayev addresses its development through engineering computer graphics [6]. Abdusaidov emphasizes the integration of computational and graphic activity [7], while Qahharov examines visual-intellectual transformation in engineering education [8]. Koliassa considers the relationship between two-dimensional graphics, spatial modeling, and digital technologies [5]. Together, these perspectives support a conception of graphic competence that connects technical performance with cognitive and methodological development.

Methodological approaches

The competency-based approach defines learning outcomes through the application of knowledge in professional situations. Students should demonstrate that they can analyze an object, select suitable representations, create a model, and prepare a technically coherent drawing. Assessment consequently focuses on the quality and justification of the graphic product. Knowledge of projection principles and standards remains essential because it allows learners to explain and verify the results produced by software [6; 7].

The activity-based approach places practical graphic work at the center of learning. Competence develops through constructing models, comparing alternatives, identifying errors, revising drawings, and presenting solutions. A suitable learning sequence is problem formulation, inquiry, design, presentation, and reflection. This sequence links the acquisition of knowledge with its application and gives the teacher opportunities to provide feedback throughout the process [7; 9].

The systems and integrative approaches connect engineering graphics with mathematics, descriptive geometry, mechanics, materials science, computer

technologies, and design activity. A graphic assignment acquires professional meaning when geometric decisions are considered alongside the function and structure of an object. Digital resources can support this connection by enabling students to move between calculations, models, and technical documentation. Integration should therefore be reflected in the content of assignments and the criteria used to evaluate them [5; 7].

The person-centered approach takes account of differences in prior knowledge, spatial ability, digital literacy, and professional interests. Tasks of increasing complexity, video demonstrations, and independent practice resources can support differentiated learning. Students who require additional guidance may work with structured exercises, while more prepared learners investigate alternative solutions. Shared learning outcomes and transparent criteria should guide both pathways, allowing individual progress to be assessed consistently [1; 3].

Organization of learning and assessment

A coherent methodological framework includes four connected elements. The content element combines projection, drawing standards, and descriptive geometry with CAD, three-dimensional modeling, and electronic documentation. The technological element provides suitable software, learning resources, and interactive access. The activity element organizes problem-based exercises, design projects, and independent modeling. The assessment element establishes criteria for evaluating both the completed product and the reasoning behind it. These elements should be planned together so that digital tools serve clearly defined graphic learning outcomes [4; 7; 9].

Project-based learning gives students an opportunity to complete an interconnected set of professional tasks. For example, a learner can analyze a technical object, identify its principal dimensions, create a digital model, prepare the required views, and explain the design solution. The educational value of the task lies in the relationship between these operations. A visually convincing model is insufficient if its drawings contain inconsistent dimensions or if the learner cannot explain the choice of representations. Reviewing the model and drawing together supports the transfer of theoretical knowledge into practice.

Problem-based tasks and case analysis can focus on incomplete views, incorrectly interpreted sections, or inconsistencies between a model and its drawing. Students identify the problem, explain its cause, and revise the representation. Blended learning can combine preliminary study of digital resources with guided classroom practice and subsequent independent work. An electronic portfolio brings together drawings, models, project explanations, and revisions, making it possible to examine the development of graphic competence over time [9].

Assessment should cover four complementary components. The cognitive component concerns graphic concepts, standards, projection principles, and modeling knowledge. The practical-activity component concerns drawing accuracy, CAD operations, model construction, and documentation. The creative-constructive component concerns the development and comparison of design alternatives. The reflective component concerns the identification of errors, justification of revisions,

and evaluation of the final result against task requirements. Taken together, these components support a broader judgment than the assessment of software execution alone [6; 8; 9].

The criteria can be applied through knowledge tasks, practical assignments, project presentations, and portfolio review. Teachers should make the expected results clear before students begin an assignment. Feedback should address the relationship between the original task, the chosen modeling procedure, and the final representation. Students can then revise their work and explain what changed. This process makes assessment part of learning and connects self-evaluation with observable evidence in the graphic product.

Pedagogical conditions and conclusion

Implementation requires appropriate software and equipment, accessible independent learning materials, professionally oriented tasks, and teachers capable of integrating digital tools with graphic pedagogy. The teacher guides students in analyzing objects, selecting representations, comparing solutions, and interpreting errors. Digital feedback should support this guidance and maintain meaningful educational interaction [2; 9]. Successful implementation also requires alignment between learning objectives, task difficulty, and assessment criteria.

The theoretical analysis indicates that developing graphic competence requires the coordinated use of competency-based, activity-based, systems, person-centered, and integrative approaches. CAD and visualization tools provide opportunities to connect drawings, spatial models, and design reasoning when embedded in purposeful learning activities. A framework combining content, technology, practical activity, and assessment can guide the organization of this work. Its practical effectiveness should subsequently be examined through empirical assessment of students' graphic performance, spatial reasoning, and reflective skills.

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METHODOLOGICAL APPROACHES TO FOSTERING STUDENTS' INDEPENDENT THINKING VIA INTELLIGENT COMPUTING SYSTEMS

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Abstract: *This article examines the role and methodological capabilities of intelligent computing systems in developing independent thinking skills among future specialists within a digital educational environment. The theoretical and practical mechanisms for enhancing students' cognitive activity, cultivating algorithmic thinking, and fostering independent decision-making through the integration of adaptive and intelligent technologies into the educational process are scientifically substantiated. Furthermore, the core methodological approaches applied in the learning process are analyzed.*

Keywords: Intelligent computing systems, independent thinking, methodological approaches, digital education, adaptive learning, algorithmic thinking, cognitive activity.

1. INTRODUCTION

The process of digital transformation in modern education and the widespread integration of intelligent technologies require students not only to master pre-existing knowledge but also to independently search for information, critically analyze it, and creatively solve complex problems. Traditional teaching methods are often based on passive listening and rote memorization of standard formulas, which proves insufficient for fully uncovering students' critical and independent thinking capabilities.

Today, information technology and intelligent computing systems are becoming an integral part of the educational landscape. Their primary advantage lies in their ability to adapt to the individual characteristics of the learner and to cultivate independent problem-solving skills. Therefore, substantiating the scientific and methodological foundations for implementing intelligent computing systems in education is one of the most pressing scientific and pedagogical tasks.

2. THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF INTELLIGENT COMPUTING SYSTEMS

In pedagogical theory, independent thinking is characterized as an individual's logical approach to resolving problems encountered in activities, and the ability to apply existing knowledge in novel situations. Intelligent computing systems, on the