INNOVATIVE PEDAGOGICAL TECHNOLOGIES IN TEACHING ENGINEERING AND COMPUTER GRAPHICS

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Abstract. This article analyzes the didactic potential of innovative pedagogical technologies in teaching the subject of engineering and computer graphics. The study highlights the effectiveness of modern digital technologies, 3D modeling, virtual environments, artificial intelligence, and interactive platforms in the educational process. Furthermore, the role of innovative methods in developing students' spatial thinking is substantiated.

Keywords: engineering graphics, innovative pedagogy, artificial intelligence, 3D modeling, virtual technologies, spatial thinking, interactive learning.

Introduction. Today, global transformations are profoundly permeating all stages of the educational system. Innovative approaches based on modern information and communication technologies, artificial intelligence, virtual reality, augmented reality, and interactive platforms are fundamentally reshaping educational content and methodology [1 – p. 12].

The discipline of engineering and computer graphics taught in technical education fields plays a crucial role in developing prospective specialists' graphical literacy, design thinking, and spatial imagination [2 – p. 26]. Through this course, students acquire practical skills such as constructing projections of geometric bodies, reading and creating technical drawings, and visualizing three-dimensional objects.

However, traditional teaching methods often demonstrate insufficient efficiency in explaining complex geometric shapes. In particular, visualizing three-dimensional forms based on two-dimensional drawings causes notable difficulties for students [3 – p. 41]. Therefore, teaching engineering graphics using modern digital technologies represents an urgent pedagogical priority.

It enables the automation, visualization, and individualization of the educational process [4 – p. 37]. Utilizing modern graphic software, e-learning platforms, and virtual laboratories in engineering graphics facilitates effective mastery of curriculum materials.

Currently, software tools such as AutoCAD, Blender, SketchUp, SolidWorks, and AI-Visualizer are widely used in engineering graphics education. These modern technologies provide opportunities to create geometric models in 3D, demonstrate them dynamically, and interactively explain complex projections [5 – p. 58].

Digital technologies also foster students' independent learning skills. In particular, virtual laboratories and interactive graphic assignments contribute significantly to enhancing the effectiveness of the educational process [6 – p. 44].

Innovative pedagogical technologies allow organizing the educational process in an interactive, student-centered format [7 – p. 29]. In teaching engineering graphics, innovative methods such as immersive technologies, cognitive projects, creative coding, AI-based visual assignments, and virtual modeling yield productive results. Through these methods, classroom interactivity increases, enabling students to analyze complex geometric objects in a virtual environment, complete graphic tasks independently, and cultivate their spatial thinking.

Through these methods, students gain the opportunity to analyze complex geometric objects in a virtual environment, observe projections dynamically, and solve graphical problems independently [8 – p. 63]. In particular, presenting geometric bodies in actual scale using VR and AR technologies demonstrates high efficiency in cultivating students' spatial thinking [9 – p. 52].

Artificial intelligence technologies are unlocking new opportunities in teaching engineering graphics. AI systems enable the design of personalized learning trajectories, automated generation of

graphic assignments, error analysis of student submissions, and the establishment of an adaptive learning environment [10 – p. 71]. Along with enhancing the efficiency of the educational process, these technologies foster student knowledge based on an individualized approach.

Platforms such as OpenAI ChatGPT, GitHub Copilot, and other AI tools support students in learning graphic tasks step-by-step. AI-based visual systems have the capability to automatically generate complex geometric models and showcase them interactively. Consequently, students' graphical reasoning and mastery levels increase [11 – p. 49].

During the study, experimental and control groups were established to evaluate the pedagogical efficacy of the methodology based on innovative technologies. According to the obtained results, an increase in student engagement, development of spatial thinking, enhancement in the quality of graphical assignments, and reinforcement of academic motivation were identified [12 – p. 66]. This confirms that a learning environment organized around modern digital and interactive technologies serves as a vital pedagogical tool for the effective instruction of engineering graphics.

In particular, 3D modeling and immersive technologies were observed to facilitate faster and more accurate comprehension of complex projections.

Conclusion. The application of innovative pedagogical technologies in teaching engineering and computer graphics significantly enhances educational effectiveness. A learning environment built upon artificial intelligence, virtual reality, 3D modeling, and interactive platforms fosters students' spatial thinking, graphical literacy, and independent reasoning skills [12 – p. 54].

In the future, developing AI-driven smart graphic platforms, improving virtual laboratories, and broadly integrating adaptive learning systems will serve as crucial priorities in engineering graphics education [11 – p. 73].

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