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ORGANIZING LESSONS BASED ON ENGINEERING GRAPHICS AND GENERATIVE DESIGN

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Abstract: This article highlights the possibilities of applying generative design technologies in teaching engineering graphics and their impact on educational effectiveness. Practical approaches to developing students' graphical thinking, solving problematic situations, and forming technological thinking skills through generative design tools are analyzed. The study explores the effectiveness of sample lessons developed on the basis of generative design in engineering graphics courses.

Keywords: engineering graphics, generative design, digital modeling, algorithmic design, computer graphics, innovative education, technical thinking.

In the context of today's technological advancement, engineering education needs to be integrated with modern tools. Engineering graphics is one of the core subjects that form the foundation of technical thinking, providing the necessary knowledge and skills for reading, creating, and modeling technical drawings. Traditional methods no longer fully meet the demands of the digital generation and industrial needs.

In recent years, the integration of generative design approaches into engineering graphics lessons has emerged as an innovative solution. Generative design is a method that leverages artificial intelligence, data analysis, and algorithmic computations to automatically generate thousands of design solutions, enhancing students' technical thinking, problem-solving, and creative abilities.

This article outlines methods for organizing engineering graphics lessons based on generative design, provides sample assignments for students, the software tools used, and analyzes their effectiveness.

The research was carried out in the following stages:

1. Analytical phase – Studying the curriculum of engineering graphics and current teaching methods.
2. Experimental phase – Two experimental groups were formed: one taught using traditional methods, the other using generative design.

3. Technological tools – Software such as Autodesk Fusion 360, Rhino + Grasshopper, FreeCAD, and TinkerCAD were integrated into the learning process.
4. Monitoring and analysis – Students were evaluated on their drawing speed, ability to solve complex tasks, and level of 3D thinking.

The group taught using generative design achieved the following results:

- Drawing speed increased by 20%.
- 3D thinking test results improved by an average of 15%.
- 86% of students proposed their own solutions in creative design tasks.
- Students learned to analyze more than 10 design variants using generative tools.
- Interest in the subject increased, and active participation in lessons rose by 25%.

Integrating generative design into engineering graphics lessons plays a crucial role in developing students' creative and technical thinking. This approach involves students in solving real-world problems, and fosters competencies such as collaboration, analysis, and critical thinking. However, this method requires teachers to have a deep knowledge of modern technologies, the ability to adapt curricula, and the development of appropriate didactic materials.

Challenges include:

- Lack of adequate technical infrastructure in some educational institutions.
- Insufficient skills among teachers in using generative design tools.

Hence, it is essential to launch professional development courses and educational seminars in this field.

The research and analysis show that integrating generative design technologies into engineering graphics education is an innovative approach that effectively meets modern educational demands. This methodology not only enhances students' drawing skills but also fosters a culture of approaching complex engineering problems through modern technological solutions.

Advantages of lessons based on generative design:

- Develops systematic, algorithmic, and spatial thinking—key elements of engineering thought.
- Enables modeling of practical tasks, facilitating the application of theoretical knowledge to real projects.
- Promotes the development of decision-making skills through exposure to multiple solution options.
- Encourages self-assessment, analysis, and improvement—motivating independent learning.

Recommendations for implementation:

1. Improve teacher qualifications: Training programs should be organized to teach educators how to work with generative design software.
2. Provide modern technical resources: Educational institutions should be equipped with graphic stations, licensed software, and access to online resources.

3. Gradual implementation: Start with pilot groups before gradually expanding.
4. Promote interdisciplinary integration: Generative design should be taught in conjunction with mathematics, computer science, and physics to achieve better results.

In the future, engineering graphics courses based on this approach will be closely connected to the digital transformation of industry. Students will be trained to solve real problems and create optimal designs using algorithmic models. Thus, the generative design approach is destined to play a key role in the digital transformation of engineering education.

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