ANALYSIS OF LEADING FOREIGN EXPERIENCES IN TEACHING THE SUBJECT OF "ENGINEERING AND COMPUTER GRAPHICS"

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Annotatsiya:
Maqolada muhandislik va kompyuter grafikasi fanini o'qitishda xorijiy davlatlar — AQSh, Germaniya, Yaponiya, Janubiy Koreya va Singapur ta'lim tizimlarida qo'llanilayotgan ilg'or pedagogik yondashuvlar, raqamli texnologiyalar va o'quv metodlarining samaradorligi, shuningdek, xorijiy tajribani mahalliy o'quv jarayoniga moslashtirish imkoniyatlari, o'quv dasturlarini takomillashtirish yo'nalishlari va o'qituvchilarning raqamli kompetensiyalarini oshirish bo'yicha takliflar yoritilgan.

Kalit so`zlar: muhandislik grafikasi, kompyuter grafikasi, CAD/CAM/CAE, raqamli ta'lim, AR/VR, projektli ta'lim, xorijiy tajriba, innovatsion metodlar, STEAM, masofaviy ta'lim, texnik dizayn.

Аннотация:
В статье рассматриваются передовые педагогические подходы, эффективность цифровых технологий и методов обучения, используемых в системах образования зарубежных стран – США, Германии, Японии, Южной Кореи и Сингапура – при преподавании инженерной и компьютерной графики, а также возможности адаптации зарубежного опыта к местному образовательному процессу, направления совершенствования учебных программ и предложения по повышению цифровых компетенций преподавателей.

Ключевые слова: инженерная графика, компьютерная графика, CAD/CAM/CAE, цифровое образование, дополненная и виртуальная реальность, проектное обучение, зарубежный опыт, инновационные методы, STEAM, дистанционное обучение, технический дизайн.

Annotation:
The article discusses advanced pedagogical approaches, the effectiveness of digital technologies and teaching methods used in the education systems of foreign countries - the USA, Germany, Japan, South Korea and Singapore - in teaching engineering and computer graphics, as well as the possibilities of adapting foreign experience to the local educational

process, areas for improving curricula and proposals for improving the digital competencies of teachers.

Keywords: engineering graphics, computer graphics, CAD/CAM/CAE, digital education, AR/VR, project-based learning, foreign experience, innovative methods, STEAM, distance learning, technical design.

In recent decades, the rapid development of digital technologies and automated design systems has brought about fundamental changes in the system of engineering education worldwide. Engineering and computer graphics are now considered not only a traditional subject that teaches the basics of drawing, but also a core subject that forms a digital engineering culture. The experience of foreign countries shows that for effective teaching of this subject, special pedagogical conditions, innovative methods and integrated approaches are necessary.

In the US higher education system, teaching engineering graphics is closely linked to the STEM (Science, Technology, Engineering, Mathematics) concept. At universities such as Harvard, MIT (Massachusetts Institute of Technology), Purdue, and Georgia Tech, this subject is taught under the names "Engineering Graphics and Visualization" or "Computer-Aided Design and Modeling".

The following approaches are central to the learning process:

Project-Based Learning – students work as a team to create 3D models that address real-world engineering problems.

Virtual environments and simulation labs – drawings are linked to physical modeling using programs such as SolidWorks Simulation, ANSYS, and Autodesk Inventor.

N. Kalinichenko scientifically substantiated the fact that organizing training sessions with the help of electronic educational resources further increases the effectiveness of training and helps to consolidate, in particular, multimedia information is one of the main tools for increasing the cognitive abilities of students.

A. Hinze, a researcher at the University of New Zealand, conducted a pilot study in higher education to understand how mobile apps can be used by students and staff in teaching and research. The results of the pilot study showed that the needs of employees, teachers and students for using mobile educational resources are high.

According to V.A. Nikolaev and A.D. Menshikova: "The main goal of the three-dimensional system is to reduce the time, increase the quality and technical and economic level of design results, automate the formalization of documents, and improve the quality of project management. The use of automated design systems (CAD) allows you to avoid time-consuming repetitive clerical work. release, as well as simplifying changes to product design [132].

An integrated education system is created - an integral connection between engineering graphics, mechanics, materials science and computer science.

As pedagogical conditions, technical infrastructure, licensed software, open design studios for students (Design Studio), and a mentoring system in education are widely introduced.

The German engineering education system is famous for its duality principle: that is, theory and practice are carried out in an integrated manner. The following pedagogical approaches are applied in the teaching of engineering graphics at universities such as “Technische Universität München”, “RWTH Aachen”, “Karlsruhe Institute of Technology”:

CAD/CAM integration - the programs “Siemens NX”, “CATIA” and “Creo” are used in the educational process.

Cooperation with manufacturing enterprises - students implement graphic projects at real industrial facilities.

Professional competence-oriented education - graphic tasks are combined with the “Design Thinking” methodology in the educational process.

As pedagogical conditions, German universities provide each student with a practical CAD workplace, 3D printers, digital design laboratories, and network servers for modeling.

In Japan, the teaching of engineering graphics is inextricably linked with the formation of technological creativity and national engineering culture. The teaching process at Tokyo University of Technology, Osaka University and Nagoya University has the following features:

Virtual and augmented reality (VR/AR) based teaching: students work with virtual 3D models, and the design and drawing process is carried out in an immersive environment.

Gamification elements - students complete tasks in a game format, based on a step-by-step motivational model of the assessment system.

Interdisciplinary approach - the subject "Computer Graphics" is integrated with the courses "Robotics", "Design Technology", "Automation".

As pedagogical conditions: interactive smart laboratories, high-quality visualization systems, and the practice of assessing classes through digital portfolios have been established.

Analysis of the experience of foreign countries shows that the following main pedagogical principles are considered a priority in teaching engineering and computer graphics:

1. Practical orientation - modeling real engineering projects in the learning process.
2. Integration of innovative technologies – teaching with CAD/CAE/VR/AR systems.
3. Interdisciplinary approach – integration with mechanics, computer science, design and physics.
4. Creation of a digital learning environment – cloud technologies, e-learning and portfolios.
5. System of continuous professional development of teachers – through international certification programs.

In recent years, systematic work has been carried out in our country to form a national information system and expand the scope of use of modern information and communication technologies in all aspects of state and social life.

In the education system of developed countries, computer graphics is aimed at the formation of the following skills: spatial imagination, graphic literacy, 3D design and visualization, engineering analysis (CAE), prototyping, team design, technical communication. A digital portfolio of students is formed on a mandatory basis.

In Germany, Korea and the USA, engineering graphics courses are conducted in integration with industry. Students: prepare 3D projects in real factories and enterprises, perform real technical tasks during practice, present their project solutions to company specialists. This approach increases the practical relevance of knowledge.

The above analysis shows that in developed countries, the discipline of "Engineering and Computer Graphics": has moved from traditional drawing to fully digital design, is taught based on 3D modeling and simulation, is enriched with AR/VR and virtual laboratories, is integrated with real industrial projects, is based on international standards, and develops the student's spatial and visual thinking skills.

In modern engineering education, the discipline of "Engineering and Computer Graphics" is of particular importance, helping students to acquire the basic skills of constructive thinking, spatial imagination, 3D modeling, drawing geometry and design processes. The development of digital technologies has required updating the methodology for teaching this discipline. Today, advanced practices of developed countries offer new approaches to computer graphics education.

Thus, the experience of foreign countries shows that pedagogical, technological and organizational integration is necessary for effective teaching of engineering and computer graphics. By adapting these practices to national conditions, it will be possible for the higher education system of Uzbekistan to form digital engineering thinking, graphic culture and creative design competencies.

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