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Methods of Improving the Methodology of Developing Students' Competences in Teaching Engineering Graphics

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Abstract: This study aims to improve the methodology for developing design and technological competence of future engineers through the teaching of engineering and computer graphics. The rapid development of technology and the increasing complexity of engineering tasks require innovative approaches to education. By integrating modern pedagogical strategies and digital tools into the curriculum, this study seeks to improve students' ability to effectively design, analyze and implement engineering solutions. A mixed-method approach was used, which included the analysis of current teaching practices, the experimental application of innovative methods and the evaluation of student results. The results show that the integration of computer modeling, interactive design tasks and collaborative projects significantly increases the design and technological competence of engineering students. These findings serve as the basis for the development of more effective teaching methodologies aimed at adapting educational practices to industrial needs and technological advances.

Keywords: Engineering graphics, teaching methods, CAD programs, 3D modeling, Interactive simulation, Students, Control group, Experimental group.

Introduction: In today's rapidly evolving technology era, the demand for highly skilled professionals capable of solving complex industrial problems in engineering is increasing. One of the key competencies required for a modern engineer is design-technological competence, which includes the ability to conceptualize, design, analyze, and implement technological solutions. This competence is particularly important in industries such as automotive, construction, and mechanical engineering, where precision, creativity, and advanced technological knowledge are required [1]. Engineering and computer graphics are key disciplines in developing this competence. These disciplines increase students' technological literacy by teaching them spatial visualization, technical drawing, and design principles. However, traditional teaching methods used in this field often fail to meet the practical needs of future engineers or do not adequately utilize the capabilities of modern digital tools and methodologies. As a result, many students, while possessing theoretical knowledge, do not acquire the practical skills that can meet the needs of industry [2].

METHODOLOGY

Integrating innovative methods into the teaching of engineering and computer graphics, including computer-aided design (CAD) programs, 3D modeling, and interactive simulation tools, can be an effective way to address this problem. This will help students apply their theoretical knowledge in real-life situations by making the learning process more interesting and practical. Also, the use of project-based learning and team assignments will help students acquire skills that are important for modern engineers, such as critical thinking, problem solving, and teamwork [3].

The purpose of this study is to develop the design and technological competencies of future engineers by

improving the methodology of teaching engineering and computer graphics. In particular, the following tasks are planned [4]:

1. To analyze the current state of teaching engineering and computer graphics.

2. To identify the main problems faced by students and teachers.

3. To propose innovative teaching methods using digital tools and active learning strategies and to evaluate their effectiveness.

By pursuing these goals, research contributes to aligning engineering education with the dynamic demands of industry and preparing students to succeed in a technology-driven world [5].

RESULT AND DISCUSSION

Analysis of advanced foreign and domestic experiences in engineering graphics The analytical method is important for improving educational processes and introducing new approaches in the scientific field. In the field of engineering graphics, this method helps to identify the most effective approaches by studying the teaching systems and practices used in different countries. When analyzing foreign and domestic experience, not only teaching methods are taken into account, but also factors such as the general structure of the education system, the interaction of students and teachers, and the level of use of technologies [6].

Advanced methods of teaching engineering graphics are widely used abroad, especially in developed countries such as the USA, Europe and Japan. In these countries, engineering graphics includes not only traditional drawing skills, but also advanced technologies such as computer-aided design and 3D modeling. The following approaches are most often used [7]:

In foreign educational institutions, for example, in the USA and Europe, CAD programs such as AutoCAD, SolidWorks, CATIA, and Rhinoceros are widely used. Through these programs, students are given the opportunity not only to create technical drawings, but also to create 3D modeling and animations. Computer-aided design allows students to develop high-resolution technical drawings and projects, which increases their practical skills [8,9].

In Europe and the USA, special programs (for example, Blender and 3ds Max) are also used to teach students 3D modeling in engineering graphics classes. With the help of these programs, students have the opportunity to create 3D models of real-life objects and test them in a virtual environment. In this way, students learn not only how to create drawings, but also how they work in practice [10].

In Europe and the USA, the project-based learning method is widespread. In this method, students learn by solving real engineering problems. For example, during the learning process, students create 3D modeling, mechanical system drawings, and other graphic materials based on projects they develop. This approach brings students closer to practice and develops their project-based problem-solving skills.

In some countries, such as Japan, interactive simulation and virtual labs are used to teach engineering graphics and design to students. With the help of these technologies, students can simulate various problems that arise when creating projects, for example, taking into account material properties, mechanical forces and other factors, and test their projects virtually.

Engineering graphics education in Uzbekistan and other Central Asian countries has its own unique characteristics. Traditional teaching methods are often focused on drawing, but in recent years modern technologies and methodologies have been introduced. An analysis of local experience shows the following characteristics:

Traditional methods: In many higher education institutions in Uzbekistan, traditional drawing and technical drawing approaches are used as the main method of teaching engineering graphics. This method teaches students skills such as creating correct drawings, maintaining symmetry and proportions, and clearly showing details. However, this method is based only on theoretical knowledge and is limited in developing students' practical skills.

Computer-aided design: Some universities in Uzbekistan have introduced CAD programs, such as AutoCAD and SolidWorks, but the teaching process using these programs can often be less effective than traditional teaching methods. To be effective in using the programs, teachers themselves need to learn advanced technologies and use interactive approaches in their lessons.

Development of project-based learning: Project-based learning is gradually expanding in local universities. In this approach, students work in groups to solve real-world engineering problems. However, the necessary infrastructure and teacher training are required for the widespread implementation of this method.

Development of project-based learning: Project-based learning is gradually gaining ground in local universities. In this approach, students work in groups to solve real-world engineering problems. However, the widespread implementation of this method requires the necessary infrastructure and training of teachers.

Simulation and laboratories: Although work is

underway to introduce virtual simulations and laboratories in local universities, these technologies are still used to a limited extent. Some large universities in Uzbekistan are upgrading their software and hardware to introduce simulations and virtual laboratories, but this process is still at an early stage.

Comparison between control and experimental groups using modern methods with students: Experimental methodology is widely used in scientific research to obtain real data and test theoretical approaches in practice. In order to study the effectiveness of using modern methods in teaching engineering graphics, the differences between the control and experimental groups of students were analyzed in the experiment. In this experiment, it was determined what improvements students achieve by using modern teaching methods and what differences they show compared to traditional methods.

The main goal of the experiment is to evaluate the effectiveness of integrating modern teaching methods - computer-aided design programs, interactive lessons, 3D modeling and project-based learning - into the educational process. The following tasks were accomplished through the experiment:

1. To determine the knowledge and skills of the group trained using modern methods in engineering graphics.

2. To compare with the group trained using traditional methods.

3. To analyze the results of both groups and determine which method is more effective.

Two groups participated in the experiment:

Control group (traditional methods): In this group, students were taught using traditional methods. In this method, the teaching was based only on the creation of technical drawings and basic drafting skills. In this group, computer-aided design programs and 3D modeling techniques were not used.

Experimental group (modern methods): In this group, students received education using modern teaching methods. In this group, computer-aided design programs, 3D modeling, interactive simulations, and project-based teaching methods were introduced.

Duration of the experiment: The experiment was conducted for two semesters. A specific subject program was determined for each group and the educational process was organized based on this program. Lessons were held twice a week, each lesson lasted 90 minutes. At the end of the experiment, practical developments and tests performed by students were evaluated.

The following methods were used in the experimental group:

Computer-aided design (CAD): Students were taught to create technical drawings and design 3D models using programs such as AutoCAD and SolidWorks. By using the programs, students had the opportunity to create not only traditional drawings, but also virtual models of them, analyze changes, and test how the designs work in practice.

3D Modeling and Visualization: Using 3D modeling software (such as Blender or SketchUp), students were given the opportunity to view and test their designs in three dimensions. This gave students the opportunity to make sure that the design was accurate and of high quality.

Project-based learning: Students were divided into groups and created practical projects to solve real-world engineering problems. During the projects, students developed skills such as teamwork, planning, task allocation, and technical problem-solving.

Interactive Simulation Using simulation software, students were given the opportunity to test their designs under different conditions. For example, simulations were conducted taking into account the strength of materials or the effects of heat. [9]

At the end of the experiment, the differences between students were as follows:

• Control group: Students trained using traditional methods gained good knowledge in creating technical drawings, but had difficulties in using 3D modeling and modern design programs.

• Experimental group: Students trained using modern methods gained much higher skills in using 3D modeling and CAD programs. They achieved high results not only in creating technical drawings, but also in developing practical projects.

Creativity and critical thinking:

• Control group: Although students trained using traditional methods achieved good results in drawing, they showed limitations in their creative approach, especially in creating projects in an innovative way.

• Experimental group: Students using modern methods achieved better results in creative approaches to projects, applying various technological solutions, and solving problems in an innovative way.

Teamwork and Collaboration:

• Control Group: While students trained using traditional methods performed well in teamwork, they were more likely to work individually and showed weaknesses in creating innovative solutions in collaboration.

• Experimental Group: Students trained using modern methods performed significantly better in working

effectively in teams, making strategic decisions for a project, and solving team problems.

The results of the experiment showed that modern teaching methods help students become more competent, creative and practical. Using CAD programs, 3D modeling and project-based teaching methods, students developed effective working skills in practice. At the same time, modern methods also encouraged students to work together and create innovative solutions. The results of this experiment indicate the need for a wider application of modern methods in the education system.

CONCLUSION

This study aims to study the effectiveness of using modern methods in teaching engineering graphics. During the study, the differences between traditional teaching methods and modern approaches and the impact of each method on students' knowledge and skills were analyzed in depth. As a result, it was found that the introduction of modern methods into the educational process has a number of advantages that provide higher results and efficiency for students.

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