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INTERNATIONAL CONFERENCE ON SUPPORT OF MODERN SCIENCE AND INNOVATION

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INTERNATIONAL CONFERENCE ON SUPPORT OF MOERN SCIENCE AND INNOVATION: a collection scientific works of the International scientific conference – Madrid, Spain, 2025, Issue 4.

Languages of publication: Uzbek**,** English, Russian, German, Italian, Spanish,

The collection consists of scientific research of scientists, graduate students and students who took part in the International Scientific online conference **«INTERNATIONAL CONFERENCE ON SUPPORT OF MOERN SCIENCE AND INNOVATION»**. Which took place in Spain, 2025.

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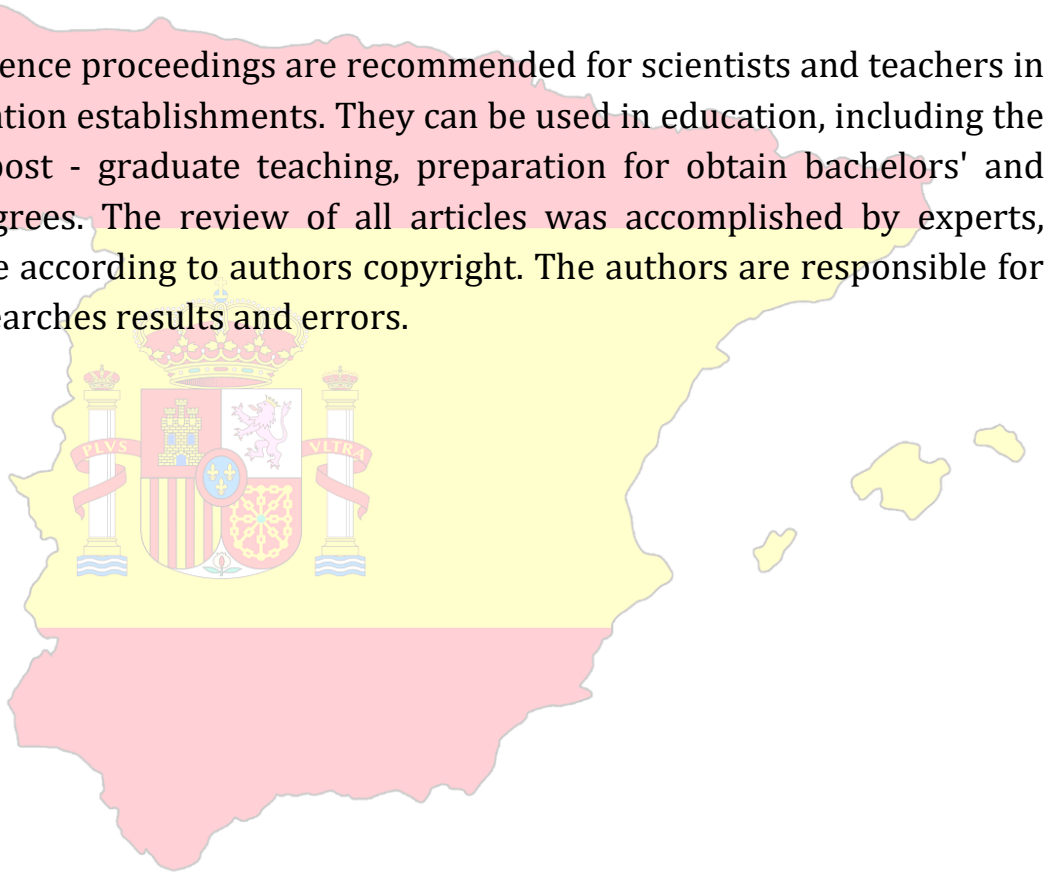

THE ESSENCE AND CONTENT OF DESIGN AND CONSTRUCTION ACTIVITY IN ENGINEERING EDUCATION

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Annotation: In this thesis, the essence, content, and modern approaches to preparing students for design and engineering activities in engineering education are analyzed. The necessity of forming students' creativity, engineering thinking, and practical design skills through the introduction of innovative, information-communication, and project technologies into the educational process in engineering fields is substantiated.

Keywords: engineering education, design and engineering activities, innovative technologies, engineering thinking, technical thinking, digital learning environment, competence, CAD/CAM/CAE systems, creative design.

Today, in the era of rapid development of technology, new requirements and tasks arise for engineering education. The digital economy, the automation of industry, and the expansion of "smart production" systems require a new approach to the process of training engineering personnel. From this point of view, the organization of design and engineering activities in engineering education and its formation as a key component of the educational process is of current importance.

Design and engineering activity allows students to combine theoretical knowledge with practice, direct them to solving real technical problems, and develop creative and technical thinking. Also, through this activity, students acquire competencies in the development of innovative ideas, modeling of technical projects, and the creation of engineering solutions.

In recent years, domestic and foreign scientists have conducted extensive scientific research on the development of engineering education and design and engineering activities, which is one of its components. Their work substantiates the need to introduce innovative, digital, and practical approaches in engineering education.

Among Uzbek scientists, A. Khusanov, M. Khaitov, Sh. Akhmedov, N. Gafurov, B. Rakhmonov, and others paid special attention to the issues of forming students' technical thinking, problem thinking, and design competencies in engineering education. In their scientific research, an important place is occupied by the integration of the educational process with production, the completion of project tasks based on digital technologies, as well as the didactic substantiation of the stages of design activity.

Sh. Karimov (2020) in his works shows that project-based learning (Project-Based Learning) in engineering disciplines is the most effective approach to the formation of students' technical thinking.

Z. Abdurakhmanov (2021) studies the mechanisms of forming creative thinking, technical design, and problem-solving skills in students through project activities.

According to Zimnyaya (2016), project-based learning in engineering education develops students' technical thinking, responsibility, and teamwork skills.

In recent years, digital technologies have become an integral part of design and engineering activities.

CAD (Computer-Aided Design), CAM (Computer-Aided Manufacturing), CAE (Computer-Aided Engineering) systems allow automating the processes of creating, modeling, and testing engineering projects (Harris & White, 2021).

In addition, BIM (Building Information Modeling) technology allows for digital modeling and data exchange in engineering and construction projects (Smith, 2020).

In recent years, the concept of "Formation of Competence in the Digital Educational Environment" has been widely implemented in the education system of Uzbekistan. This approach strengthens the need to organize design and engineering activities in engineering education in a practice-oriented, innovative, and integrative form.

Engineering education today requires not only theoretical knowledge, but also the formation of practical skills, engineering thinking, and a systematic approach. From this point of view, design and engineering activity is one of the main components of training engineering specialists.

Design and Design Activity - This includes the process of designing, modeling, analyzing, and experimentally improving technical objects, mechanisms, systems, or devices by students. This activity defines the practical direction of engineering education and develops the scientific and technical thinking of students.

In modern education, this activity includes the following stages:

- identification of the problem situation and formation of the technical assignment;
- development of an idea based on scientific and technical research;
- project modeling (using CAD, CAM, CAE systems);
- analysis and improvement of results;
- Project defense and implementation.

The essence of design and engineering activity in engineering education consists in teaching students to think independently, find technical solutions, systematically analyze problems, and express innovative ideas in practical form.

In terms of content it is integrated into the educational process, developing students' creativity through laboratory, project, and practical classes. As a result, students:

- will have the competence to create technical projects;
- learns to work with information and communication technologies;
- prepares for collective engineering activities;
- acquires skills in solving innovative problems in production conditions.

During the study, the pedagogical, technological, and innovative aspects of organizing design and engineering activities in engineering education were deeply analyzed. It has been established that students studying in the field of engineering, along with acquiring theoretical knowledge, face a number of difficulties in applying them in practice. This creates the need for the systematic application of the project approach in the educational process.

The study revealed that by integrating design and engineering activities into the educational process, students:

to develop technical thinking,

independent decision-making, analysis of problem situations,

Participation in collective engineering activities,

Those who have mastered the skills of transforming innovative ideas into practical projects.

Experimental work was conducted among students of engineering programs of the Jizzakh Polytechnic Institute, Tashkent State Technical University, and Samarkand State Architectural and Construction University.

According to the results, in groups trained on the basis of design and engineering activities, the indicators of students' completion of practical assignments were 28-32% higher.

According to the research results, it was established that the organization of design and engineering activities based on the following didactic conditions gave the most effective result:

organization of the educational process based on problem projects;

Effective use of information and communication technologies (ICT);

application of interactive teaching methods (case-study, brainstorming, teamwork);

Complete project assignments in practical cooperation with manufacturing enterprises.

These approaches have become an important factor in increasing the level of assimilation of students, activating technical thinking, and forming engineering competencies.

Analysis showed that the use of software tools such as CAD/CAM/CAE, BIM, MATLAB, ANSYS for carrying out project activities in the digital environment develops digital engineering thinking in students.

These technologies are:
simulation of complex structures in a virtual environment,
digital testing of technical solutions,
allows for the automation of production processes.

In engineering education, teaching methods based on a virtual and simulation environment expand the opportunities for students to gain experience, which increases their professional training.

These results confirm the possibility of a comprehensive formation of students' professional competencies through the introduction of design and engineering activities into the educational process.

The obtained results were compared with the opinions of domestic and foreign researchers.

For example, the scientific views of D. Kolb (2014) on the "experience-based learning model" and R. Marra (2019) on the "project-based learning approach" practically confirm the results of this study.

The results show that design and engineering activities in engineering education:
serves to transform students' theoretical knowledge into practical skills;
forms engineering thinking;
directs towards mastering digital and innovative technologies;
strengthens the integration of production and education.

Conclusion: Organization of design and engineering activities in engineering education is the most important factor in the formation of future engineers as digital, creative, and technologically thinking specialists. The systematic application of the project approach in the educational process develops students' skills in analyzing problem situations, developing technical solutions, and implementing them in practice.

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