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MAIN FACTORS OF PREPARING STUDENTS FOR DESIGN AND CONSTRUCTION ACTIVITIES

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Annotation: This article analyzes the main factors influencing students' design and engineering activities. Today, in the education system, the development of knowledge and skills aimed at engineering and design activities is of great importance. The article highlights such key factors as educational methods, digital technologies, integration with practice, and the development of creative thinking in preparation for design and engineering activities. Also, the effectiveness of modern pedagogical technologies and innovative approaches is analyzed, and ways of their implementation in the educational process are considered. The research results serve to improve the quality and effectiveness of education in engineering and technical fields. As a result of this article, the main factors influencing the preparation of students for design and engineering activities are identified, and scientific-theoretical and practical recommendations for their development and improvement are developed. Also, the effectiveness of modern innovative technologies and pedagogical approaches is assessed, and strategic proposals for their application in the educational process are given. These include the application of advanced pedagogical technologies, the introduction of digital technologies, the expansion of practical and laboratory classes, the development of engineering education, and the encouragement of independent creative thinking among students.

Keywords: design and engineering competence, innovative approach, digital technologies, creative thinking, pedagogical technologies.

Today, the rapid development of technological progress requires increased attention to engineering and design directions in the education system. Innovative projects, engineering solutions, and creative design approaches are becoming increasingly important in the modern economy and industrial sectors. Therefore, the issues of preparing students for design and engineering activities and developing their corresponding competence are relevant.

The main factors in preparing students for design and engineering activities are:

1. Factors related to the content of education: In preparing students for design and engineering activities, the content of education occupies a central place. The content of educational programs should be aimed at the formation of modern constructive thinking, ensure interdisciplinary integration, and be oriented towards solving practical problems. The interconnectedness of such disciplines as drafting, materials science, fundamentals of mechanical engineering, mechatronics, automated design, aerodynamics, and stress theory develops structured design thinking. It is important that curricula are updated in accordance with the requirements of real production, taking place in the content of new technologies (additive production, digital prototyping, IoT, CAD/CAE). Practice-oriented assignments, project work, and modeling classes for real objects deepen students' knowledge and strengthen their design competencies.

2. Factor of pedagogical technologies and methods: Modern pedagogical technologies are one of the decisive factors in the effective preparation of students for design activities. Project-based learning (PBL) forms constructive thinking, allowing students to independently solve practical problems. Problem-based learning methods require students to analyze technical tasks, develop alternative solutions, and choose the optimal option. STEAM methodology strengthens creativity and an innovative approach through the integration of science and technology. Digital educational technologies - virtual laboratories, simulation systems, digital twins (Digital Twin)

platforms - serve to make the design process more realistic and analytical. These methods increase student activity, creative thinking, and analytical abilities.

3. Digital environment and technical support factor: The presence of a digital environment and sufficient technical support play a decisive role in design and engineering activities. CAD/CAM/CAE programs - SolidWorks, CATIA, Siemens NX, AutoCAD, ANSYS, Matlab Simulink - introduce students to modern design processes. 3D printers, 3D scanners, CNC machines, laser cutting equipment, and FabLab environments give the student the ability to create real models. With the help of virtual prototyping, 3D simulation, a model of a digital engine and mechanism (Digital Prototype), the student preliminarily analyzes the force, load, aerodynamic or vibrational characteristics of project solutions. This improves the quality of the project, reduces errors, and brings it closer to the production process. With a strong digital technical base, students acquire high-level design skills much faster.

4. Individual-psychological factors: Constructive activity requires a high level of creativity, logical thinking, imagination, and an analytical approach to the problem from students. Therefore, the personal and psychological characteristics of students are considered important in the process of preparation. Abilities such as technical thinking, spatial imagination, innovative thinking, the creation of alternative solutions, and the ability to assess risks are the main foundation of design activity. Moreover, the student's motivation, need for mastery, professional goals, and aspirations determine their constructive activity. Soft-skills competencies, such as teamwork, joint decision-making, leadership, and conflict resolution, are also important factors in project success.

5. Factors related to the professional and pedagogical competence of teachers: The high professional potential, design experience, and methodological competence of a teacher are directly related to the quality of student training. The teacher must have a deep knowledge of technical design processes, effectively use modern CAD/CAE programs, and possess real design experience. It should also be able to guide students towards independent research and creative thinking. Pedagogical mastery, the correct organization of project assignments, the development of assessment criteria, working with the student as a mentor further strengthen the teacher's role in the training process. The presence of the teacher's cooperation with industrial enterprises increases the possibility of providing the student with a real experience.

6. Factors of integration with production: Integration of education with production is very important in preparing students for design activities. This process includes such activities as internships, dual education at enterprises, seminars with specialists, and project development based on technical orders. Based on the problems of real enterprises, students develop constructive solutions, work with technical assignments, study technological processes, and analyze technical and economic indicators, which significantly increases their professional training. Integration with production develops in students such skills as responsibility, practical thinking, making decisions appropriate to the real situation, and assessing the economic efficiency of the facility.

7. Regulatory and organizational factors: The regulatory framework of the educational process forms the organizational basis for preparing for design activities. Higher education standards, competency models, methodological guidelines for interdisciplinary integration, and state decisions on supporting innovative technologies create the necessary legal basis for this process. The strategy of innovative development of universities, the policy of creating modern laboratories, and funds for supporting startups and projects will also strengthen the creative activity of students. From an organizational point of view, it is also important to transition the educational process to a modular system, maintain a project portfolio, and implement a competency-based assessment system.

8. Assessment and monitoring factors: The assessment process in preparing students for design and engineering activities allows for the accurate identification and development of their

professional competencies. The assessment system should not be based on traditional tests or theoretical examinations, but should include such criteria as constructive thinking, creativity, the effectiveness of technical solutions, safety, and economic justification. A monitoring system based on portfolios, project defenses, assessment of the quality of technical assignment execution, and selection criteria encourages students to grow professionally. Transparent, open, and competency-based assessment will clearly demonstrate the student's progress at each stage.

These factors help students become more effective and competitive in design and engineering activities. This article analyzes the main factors influencing the design and engineering activities of students. Also, the effectiveness of modern teaching methods and innovative approaches will be studied, and practical recommendations for their implementation in the educational process will be developed. The research results will serve to improve the quality and effectiveness of education in engineering and technical fields in the future.

The problem of preparation for design and engineering activities has been widely studied by scientists and researchers around the world. Scientific works carried out in this direction cover such aspects as pedagogy, engineering education, the integration of innovative technologies and digital technologies into the educational process. Below is an overview of important research and literature on this topic:

1. Pedagogical approach and methodological research: J.W.Thomas - conducted research on the integration of the project-based learning method into the educational process. In his works, the possibilities of improving students' problem-thinking abilities by involving them in design activities were considered. In his work "Designing Constructivist Learning Environments," D.H. Jonassen analyzed the effectiveness of the constructivist approach in the development of design and engineering competence. J.L. Kolodner studied the possibilities of developing students' design abilities based on cognitive science and project-based learning methods.

2. Research on Engineering Education: Felder & Brent - The ABCs of Engineering Education highlights the importance of project-based education in engineering education and its impact on students' independent engineering thinking. L. Dym et al. - in the work "Engineering Design Thinking, Teaching, and Learning" analyzed modern teaching methods in engineering design. Prince & Felder - researched the results of incorporating active learning methods, including practical projects and teamwork into engineering education.

3. Digital technologies and innovative approaches: S.Papert - in the book "Mindstorms: Children, Computers, and Powerful Ideas" proved the possibility of developing students' design skills using programming and technologies. M.Resnick - researched methods for orienting students towards engineering and design activities through Scratch and other visual programming environments. B.Kim, R.Reeves - in the study "Reengineering engineering education with virtual laboratories" showed ways to improve engineering education through virtual laboratories. G.Fischer, in his work "Computational Literacy and Design Thinking," analyzed the advantages of computerized design environments for students.

4. STEAM educational approach and creative thinking: G.Yakman - conducted research on the integration of the STEAM (Science, Technology, Engineering, Arts, Mathematics) model into the educational system and proved the importance of this approach in the development of design and engineering competence. Bequette & Bequette presented research results on the development of engineering education based on art and design in the article "A Creative Approach to Teaching Engineering."

Scientific research by scientists shows that in design and engineering activities: Innovative pedagogical approaches (project-based learning, problem-based learning, research-based learning) are of great importance; Digital technologies and virtual laboratories serve to make the educational process interactive and improve the engineering abilities of students; The STEAM approach increases students' creativity and helps them better master design and engineering work.

Based on the analysis of this scientific literature, the article developed specific recommendations for the application of modern approaches in preparing students for design and engineering activities.

To highlight the topic of the main factors of preparing students for design and engineering activities, the following methods can be used:

1. Theoretical-analytical method: Study of the scientific and theoretical foundations of preparation for design and engineering activities; Analysis of pedagogical technologies and innovative approaches. Application: analysis of scientific sources and pedagogical research related to the development of science and technology; Study of literature on the modern competency-based approach, engineering education, and creative thinking.

2. Empirical research methods: Identification and assessment of practical processes in preparing students for design and engineering activities; Verification of the effectiveness of the educational process and determination of directions for its improvement. Application: Questionnaires and interviews: Study of students' and teachers' attitudes towards project activities; Observation: Monitoring students' design activities and identifying their problems; Pedagogical experiment: Testing various methods and studying their effects.

3. Diagnostic and assessment methods: Determining the readiness of students for design and engineering activities and assessing the dynamics of their development. Determining the effectiveness of methodological influence. Application: Tests and assessment criteria: Assessment of students' knowledge and skills; Portfolios: Analysis of projects created by students; Expert evaluation: Evaluation of students' work by experienced specialists.

4. Innovative approaches: Preparation for design and engineering activities using modern technologies; Improvement of creative and engineering skills by involving students in practical activities. Applications: Digital technologies: CAD programs, 3D modeling, simulations and virtual laboratories; STEAM approach: Integration of elements of science, technology, engineering, art, and mathematics; Problem-based learning: Directing students towards solving real problems.

5. Statistical analysis methods: Testing the reliability of the research results; Determination of the effectiveness of experimental action. Application: comparison of the results of the experimental and control groups; Mathematical-statistical analysis: Analysis and generalization of the obtained results using statistical methods. These methods allow ensuring the scientific validity of the article, covering theoretical and practical aspects, as well as a deep analysis of the process of preparing students for design and engineering activities.

The results achieved in the article on the topic "The main factors in preparing students for design and engineering activities" are as follows:

1. Theoretical results. Scientific foundations of preparation for design and engineering activities are determined; The basic theoretical concepts of the competency-based approach are systematized; Methods of developing students' competence in engineering-educational integration are highlighted; the main factors influencing design and engineering activities are analyzed; The impact of digital technologies and digital tools is determined; The importance of practical experience, creative thinking, and teamwork will be studied.

2. Practical results. Effective educational and methodological recommendations are developed for students; Preparation of innovative educational and methodological materials on design and engineering; Effective ways of involving students in design and engineering activities are proposed; The methodology for preparing for design and engineering activities will be improved using modern technologies; Ways of implementing 3D modeling, CAD programs and simulations in the educational process will be developed; Strategies for solving practical problems are developed using the STEAM approach.

3. Pedagogical results. Assessment of the effectiveness of preparation for design and engineering activities; Criteria for assessing the competence of students are defined and

implemented in practice; The results of the experimental and control groups are analyzed; The development of students' knowledge, skills, and abilities is observed; The results of independent design and engineering work are studied; Projects created by students are evaluated qualitatively.

4. Innovative results. The effectiveness of innovative teaching methods and technologies is determined; New methods and interactive technologies will be introduced into the educational process; The possibilities of integrating design and engineering classes into the curriculum are determined; Wide implementation of digital technologies and interactive approaches in the pedagogical process; Virtual laboratories, simulations, and digital training platforms will be developed. Through problem-based learning methods, students are oriented towards creative thinking.

As a result of the article, an effective model is proposed based on scientific-theoretical, practical, and innovative approaches to preparing students for design and engineering activities. Recommendations for improving the educational process in this area will also be developed.

It is one of the important directions of modern technical and engineering education in preparing students for design and engineering activities. Today, the identification and effective use of factors influencing the formation of this competence is of great importance in improving the quality of education and preparing students for practical engineering activities.

Discussions and suggestions. To make preparation for design and engineering activities more effective, the following proposals can be put forward: Wide application of hybrid and digital technologies in engineering education; Engaging students in real projects and startup activities; Increase the number of practical lessons for the formation of analytical and problem-solving competence; Bringing students closer to the production process by strengthening cooperation between education and industry.

Preparing students for design and engineering activities is a multifactorial process, in which such factors as digital technologies, practical teaching methods, cooperation with industry, and a problem-based approach play an important role. As a result of the combination of these factors, students acquire the skills of independent work in a modern engineering environment, the development of projects with a creative approach, and the solution of real problems.

Also, close integration with production, increasing experience and practical classes, and the use of advanced technologies play an important role in the development of students' competence. As a result, the possibility of training competitive, innovative-thinking specialists with practical skills increases.

In this article, the main factors influencing the preparation of students for design and engineering activities were analyzed. As a result of the study, the following important aspects were identified:

Innovative technologies, practical exercises, and problem-based learning approaches play an important role in preparing for design and engineering activities; To increase the technical creativity of students, it is necessary to integrate modern teaching methods, including 3D modeling, simulations, and digital technologies into the educational process; Along with theoretical knowledge, practical experience and independent project activity are the main factors in the development of competence; With the introduction of innovative approaches, distance and hybrid teaching methods in the educational process, students will acquire more effective skills in design and engineering; By improving the criteria for assessing competence, it is possible to determine the dynamics of the development of students' knowledge and skills and improve the quality of education.

In general, this article sets out the scientific and theoretical foundations for preparing students for design and engineering activities, reveals the effectiveness of innovative pedagogical approaches, and provides practical recommendations for their implementation in the educational process.

REFERENCES

1. Jonassen, D. H. "Learning to Solve Problems: A Handbook for Designing ProblemSolving Learning Environments" - Routledge, 2011.

2. Kolodner, J. "Case-Based Reasoning and Learning in Engineering Design" - IEEE Transactions on Systems, 2015.

3. Turaev K., Yadgarov N., Mamatov D. The role and practical significance of interesting issues in the development of students' cognitive competencies //E3S Web of Conferences. EDP Sciences, 2024. - Vol. 538. - P. 05045. https://www.scopus.com/record/display.uri?eid=2-s2.0-85196835458&origin=recordpage

4. Umirov A. et al. The current state of soybean production and its size-mass indicators in the conditions of Uzbekistan //BIO Web of Conferences. EDP Sciences, 2024. - Vol. 105. - Б. 105-110. https://www.scopus.com/record/display.uri?eid=2-s2.0-85192545367&origin=recordpage

5. Turayev, X. A. et al. Methodological Recommendations for Implementing the Topic of Forty in Graphic Drawing Lessons // Science and Education. - 2021. - Vol. 2. - No. 2. - P. 264-268.

6. Turaev Kh. A. "Graphical Foundations for the Development of Design Competence of Future Drawing Teachers." - T.: Monograph. 2021.

7. Turayev K. A. Improving the methodology for developing the design and construction competence of future drawing teachers: diss. - Dissertation written for the degree of Doctor of Philosophy (PhD) in Pedagogical Sciences, 2022.

8. UNESCO. "Engineering Education and Innovation for the Future," 2022. (www.unesco.org)

9. European Commission. "Digital Competence Framework for Educators," 2020. (www.ec.europa.eu)

10. IEEE Xplore Digital Library. "Innovative Methods in Engineering Education." (www.ieeexplore.ieee.org)