

**DEVELOPMENT OF PEDAGOGICAL TEACHING TECHNOLOGIES IN  
ENGINEERING HIGHER EDUCATIONAL INSTITUTIONS IN THE  
CONDITIONS OF DIGITAL TRANSFORMATION IN THE ENERGY SECTOR**

**Pardaboyev A**

*Jizzakh Polytechnic Institute*

*Teacher of the department of power engineering*

**Annotation**

This article analyzes the issues of improving pedagogical teaching technologies in engineering higher education institutions in the context of the acceleration of digital transformation processes in the energy sector. The role of digital technologies, artificial intelligence, virtual laboratories, distance learning platforms and interactive teaching methods in improving the quality of education is highlighted. The advantages of using innovative pedagogical technologies in developing the professional competence of students studying in the energy sector are also shown.

**Keywords**

Digital transformation, energy, engineering education, pedagogical technologies, innovative education, digital competence, virtual laboratory, artificial intelligence.

**Аннотация**

В данной статье анализируются вопросы совершенствования педагогических технологий обучения в инженерных высших учебных заведениях в контексте ускорения процессов цифровой трансформации в энергетическом секторе. Подчеркивается роль цифровых технологий, искусственного интеллекта, виртуальных лабораторий, платформ дистанционного обучения и интерактивных методов обучения в повышении качества образования. Также показаны преимущества использования инновационных педагогических технологий в развитии профессиональной компетентности студентов, обучающихся в энергетическом секторе.

**Ключевые слова**

цифровая трансформация, энергетика, инженерное образование, педагогические технологии, инновационное образование, цифровая компетентность, виртуальная лаборатория, искусственный интеллект.

**Annotatsiya**

Mazkur maqolada energetika sohasida raqamli transformatsiya jarayonlarining jadallashuvi sharoitida muhandislik oliy ta'lim muassasalarida pedagogik o'qitish texnologiyalarini takomillashtirish masalalari tahlil qilingan. Raqamli texnologiyalar, sun'iy intellekt, virtual laboratoriyalar, masofaviy ta'lim platformalari hamda interaktiv o'qitish metodlarining ta'lim sifatini oshirishdagi o'rni yoritilgan. Shuningdek, energetika

yo‘nalishida tahsil olayotgan talabalarning kasbiy kompetentligini rivojlantirishda innovatsion pedagogik texnologiyalardan foydalanishning afzalliklari ko‘rsatib berilgan.

## **Kalit so‘zlar**

raqamli transformatsiya, energetika, muhandislik ta‘limi, pedagogik texnologiyalar, innovatsion ta‘lim, raqamli kompetentlik, virtual laboratoriya, sun‘iy intellekt.

**INTRODUCTION:** Today, digital transformation processes are developing rapidly in all sectors of the world economy. In particular, the energy sector is undergoing a radical transformation based on modern information and communication technologies, artificial intelligence, large-scale data processing (Big Data), the Internet of Things (IoT), cloud technologies and smart energy systems (Smart Grid). These processes require specialists working in the energy sector not only to have deep professional knowledge, but also to have the competencies to effectively use digital technologies, innovative thinking and solve complex engineering problems based on modern approaches. The digitalization of the energy sector poses new challenges for the higher education system. In particular, there is an increasing need to improve the content of education in engineering higher education institutions based on modern technologies, digitize pedagogical processes and widely introduce innovative teaching technologies. Since traditional teaching methods cannot fully meet the changing requirements of modern production, the integration of interactive methods, virtual laboratories, distance learning platforms, simulation programs and artificial intelligence-based educational tools into the educational process is becoming an urgent issue. Large-scale reforms are also being implemented in our country to modernize the energy sector and develop the digital economy. In the Republic of Uzbekistan, within the framework of the “Digital Uzbekistan - 2030” strategy, special attention is paid to the introduction of digital technologies in all sectors of the economy, the development of human capital and the training of modern specialists. This creates the need to take educational processes in higher educational institutions in the energy sector to a new level, prepare students for future professions and form their digital competence. The development of pedagogical teaching technologies in the context of digital transformation is one of the important factors in improving the quality and efficiency of education. Modern pedagogical technologies allow students to develop independent learning skills, form practical knowledge, and improve creative and critical thinking skills. At the same time, the use of digital learning environments ensures the flexibility of the learning process and serves to create individual learning trajectories.

## **LITERATURE REVIEW**

The issues of digital transformation in the energy sector and the development of pedagogical technologies in engineering education have become one of the important areas of scientific research in recent years. In world practice, a lot of scientific research is being conducted on the integration of digital technologies into the education system, improving the quality of education and developing the professional competence of future engineers. In reports prepared by international organizations, the digital transformation of the higher education system is recognized as a priority area of modern educational policy. According

to UNESCO experts, digital technologies are of great importance in individualizing the educational process, expanding the possibilities of using educational resources and increasing the efficiency of teaching. The organization's specialists emphasize that the use of digital platforms, virtual laboratories and distance learning systems in higher educational institutions contributes to improving the quality of education. The scientific work of scientists such as Bates, Anderson, Laurillard is of particular importance in the field of engineering education. Bates (2023) analyzed modern approaches to organizing the educational process in a digital learning environment and showed the advantages of electronic learning tools and distance learning technologies. Anderson (2023) studied the theoretical foundations of online education and substantiated the effectiveness of a student-centered approach in the educational process. Laurillard's research covered the issues of creating an interactive and effective learning environment using digital technologies. The issues of digitizing engineering education have also been widely studied by scientists from the CIS countries. In particular, the studies of Verbitsky, Selevko and Polat analyzed the pedagogical potential of the competency-based approach, distance learning technologies, and electronic learning resources. According to them, modern pedagogical technologies serve to improve the quality of professional training of future specialists. Among the Uzbek scientists, Sh. Sharipov, N. Muslimov, B. Khodjaev, U. Begimkulov, A. Abdukodirov and other researchers have scientifically substantiated the issues of digitization of education, improvement of pedagogical technologies and development of professional competence. Their research highlights the role of electronic educational resources, distance learning technologies and innovative pedagogical methods in increasing the effectiveness of education.

### **RESEARCH METHODOLOGY**

This study used scientific approaches aimed at studying the theoretical and practical aspects of the development of pedagogical teaching technologies in engineering higher education institutions in the context of digital transformation in the energy sector. The research methodology includes systematic, competency-based, activity-oriented and digital learning environment-based approaches. The theoretical basis of the study was formed by scientific works of local and foreign scientists on digital transformation, engineering education, personnel training for the energy sector, innovative pedagogical technologies and the development of professional competence. During the study, scientific literature, monographs, scientific articles, regulatory legal acts and reports of international organizations were analyzed.

#### **The following scientific methods were used in the research process:**

1. Method of analyzing scientific literature. Existing scientific sources on the digitalization of the energy sector, modern trends in engineering education and pedagogical technologies were studied. Using this method, the state of the problem, its theoretical foundations and development prospects were clarified.

2. Method of comparative analysis. The experiences of engineering education in developed countries in the context of digital transformation were analyzed and their possibilities for application in the higher education system of Uzbekistan were assessed.

The advantages and disadvantages of traditional and innovative pedagogical technologies were also compared.

3. Systematic approach method. The process of training engineers in the energy sector was studied as a single pedagogical system. The interrelationship of educational content, pedagogical technologies, digital tools, and teacher and student activities was systematically analyzed.

4. Observation method. The organization of educational processes in engineering higher education institutions, the use of modern information and communication technologies, and the practical application of pedagogical technologies were observed. Based on the results of the observation, existing problems and opportunities for their elimination were identified.

5. Questionnaire and interview method. The level of use of digital educational technologies, existing problems and needs were studied through questionnaires conducted among professors and students. Through interviews, feedback was collected on the effectiveness of using innovative pedagogical technologies in the educational process.

6. Statistical analysis method. The data obtained during the study were processed and summarized using mathematical and statistical methods. The results were analyzed in the form of tables and diagrams, and the impact of pedagogical technologies on educational effectiveness was assessed.

## **RESULTS AND DISCUSSION**

During the study, the impact of digital transformation processes on the activities of higher education institutions in the energy sector and the possibilities for the development of pedagogical teaching technologies were analyzed. The results obtained showed that the introduction of digital technologies into the educational process is an important factor in the development of students' theoretical knowledge, practical skills and professional competence. As a result of the analysis, it was determined that the need for knowledge and skills of students studying in the energy sector in modern digital technologies is increasing year by year. In particular, there was an insufficient level of practical training in the use of Smart Grid technologies, artificial intelligence, IoT (Internet of Things), SCADA systems and energy management programs. Therefore, there is a need to widely introduce innovative pedagogical technologies into the educational process. During the study, the effectiveness of the use of virtual laboratories, e-learning platforms and project-based teaching methods was studied. The results showed that the use of these technologies increases student activity, forms independent learning skills, and develops competencies for solving practical problems. In particular, the research conducted by Bates, Anderson and Laurillard specifically emphasized the role of digital technologies in improving the effectiveness of education. The results of this study also showed that the use of innovative pedagogical technologies in the training of energy engineers increases the quality of education. The development of the energy sector in the context of digital transformation requires new knowledge and skills from specialists. Therefore, higher education institutions should enrich their curricula with modern technologies, increase the digital competence of professors and teachers, and expand the use of innovative pedagogical approaches in the educational

process. Based on the results of the research, it can be noted that the use of virtual laboratories, project-based learning, distance learning platforms and artificial intelligence technologies allows preparing energy students in accordance with the requirements of the modern labor market. This will serve to train highly qualified engineering personnel who can effectively operate in the processes of digital transformation of the energy sector.

### **CONCLUSION**

The acceleration of digital transformation processes in the energy sector poses new challenges for higher education institutions in terms of improving educational content and pedagogical technologies. The widespread use of Smart Grid, artificial intelligence, IoT, Big Data and cloud technologies in the modern energy network requires high-level professional and digital competencies from future engineers. Therefore, the introduction of innovative pedagogical technologies in engineering education is one of the pressing issues of today. The results of the study showed that the use of digital educational technologies, virtual laboratories, project-based learning, distance learning platforms and artificial intelligence tools is of great importance in improving the quality of students' knowledge, developing their independent learning skills and strengthening their readiness for practical work. These technologies ensure the interactivity of the educational process and effectively develop students' professional competence. Based on the analysis, it was determined that it is necessary to enrich educational programs in the energy sector with modern digital technologies, increase the number of virtual and simulation laboratories, systematically improve the digital competence of professors and teachers, and strengthen cooperation with manufacturing enterprises. Also, the widespread use of innovative pedagogical approaches in the educational process will help increase the adaptability of future engineers to the demands of the labor market.

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