

Eureka Journal of Education & Learning Technologies (EJELT)

ISSN 2760-4918 (Online)

Volume 2, Issue 4, April 2026



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<https://eurekaopenaccess.com/index.php/2>

ANALYSIS OF MODERN PEDAGOGICAL APPROACHES AND PROBLEMS IN TEACHING THE ENERGY SECTOR

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Abstract

This article analyzes the relevance of using modern pedagogical technologies in teaching the energy sector, their effectiveness in the educational process, and existing problems. The study demonstrates the advantages of implementing innovative teaching methods, digital technologies, 3D modeling, and virtual laboratories. Practical proposals for improving the educational process will also be provided.

Keywords: Energy, education, innovative technologies, VR and AR simulators, Blender program, AutoCAD 3D, 3D modeling, virtual laboratory, pedagogical approach, problem, solution.

Introduction

Today, the energy sector is important as a strategic sector of the country's economy. Therefore, training qualified specialists in this field is one of the priority areas of state policy. However, in recent years, there has been a decrease in the effectiveness of traditional teaching methods and an insufficient use of modern technologies in the educational process in the field of energy. In this

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regard, the widespread introduction of modern pedagogical approaches, innovative technologies, and the digitalization of practical sessions into the educational process is becoming an important issue.

Main part

Among the main features of the educational process in the energy sector are - energy sciences require a deep understanding of complex technical processes, heat exchange, mechanical and electrical systems. Therefore, it is very important to combine theory and practice in education in this direction. For students, it is not enough to theoretically study such topics as boiler plants, heat exchange systems, steam generators, and the operating principles of power plants only through textbooks. Teaching them using technologies such as visual aids, virtual experiment programs, and 3D modeling increases learning efficiency. For example: when teaching students about power plant installations, only theoretical knowledge is imparted, while in practice, the task of studying them with one's own eyes is considered somewhat complex. Therefore, in the current developed era, the use of visualization and simulation tools is very effective in explaining to students in a realistic, visual manner.

The following modern pedagogical approaches are yielding results in the energy sector:

- **Modular education system** - the gradual formation of students' knowledge by teaching each topic as an independent module. Each module consists of goals and results, theoretical and practical exercises, control questions and tests, and independent work assignments. In this system, each module includes laboratory sessions related to real power plants, electrical systems, generators, and turbines, which are mastered by students, and an intermediate control is conducted at the end of the module. As a result, the level of knowledge of students is clearly visible.

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-Project-based learning is the linking of theoretical knowledge with practice through students' work on a practical project. These approaches are modern, practical, and innovative, preparing students for a real production environment. Through such a system, students become specialists capable of making independent decisions on the design, management, and optimization of energy processes.

- **Use of information and communication technologies** - implementation of virtual laboratories, simulators, and digital educational platforms. With the help of these technologies, the processes of electricity production, transmission, distribution, and consumption are managed and controlled in digital form, yielding positive results such as energy saving and efficiency improvement, early fault detection, accident reduction, reduction of the human factor, and enhanced automation.

- **Blended learning** - facilitating the educational process by combining online and offline learning forms. Blended learning is effective in technical fields such as energy, as it allows you to study theory online and practice in a laboratory or industrial setting. Currently, the importance of 3D modeling, VR (virtual reality), and AR (augmented reality) technologies in teaching energy sciences is increasing. For example, by modeling the internal structure of a steam boiler in 3D using Blender or Unity software, students can clearly visualize the boiler's operating process. This method not only makes the lesson interesting but also allows students to visually understand complex technical processes.

One of the programs for 3D modeling and visualization is Blender. The advantages of this program are as follows: the internal parts of the boiler (drum, pipe, combustion chamber, etc.) can be constructed in 3D and shown in cross-sections; it is free and unlicensed, has professional-level 3D capabilities, is easy for students to master, and can be used in many fields. In the program, the student can create a 3D animation and dynamically see the movement of gas and water inside the boiler, the formation of steam, and can color and move them. The

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AutoCAD 3D program allows for the creation of precise technical drawings and 3D models at the engineering level, as well as the ability to draw drawings at a precise, professional level and the function of automatically converting 2D drawings into 3D models. This software has a free license for students.

With the help of **virtual reality (VR)** simulators, students can access a full virtual model of a power plant, create its internal structure, the operating principle of boilers, turbines, generators and other elements in 3D format, and test their operation in real time. This helps to identify project errors in advance. Safety in power systems is one of the most important issues. With the help of VR simulators, employees practice various emergency situations in safe conditions and learn how to act correctly in emergency situations.

Augmented reality (AR) simulators enrich the operation of real laboratory instruments or devices with additional data by placing virtual data on top of them. This improves the quality of maintenance and reduces human error. AR technology allows monitoring and controlling energy systems in real time.

Observations and analyses conducted in connection with the study showed that although the issue of developing the energy creativity of future teaching staff is currently being studied as one of the pressing problems of the specialist training system, the current state, educational and methodological support, and material and technical base have not been formed at the level of today's innovative requirements. These problems were confirmed based on the results of observations, surveys, and interviews conducted within the framework of the study. The pace of innovation in renewable energy, energy conservation, and smart grid technologies is often outpaced by the ability of universities to update curricula due to rapidly evolving technologies and rigid curricula. Due to interdisciplinary differences, many teachers have limited technical knowledge, which makes it difficult to teach engineering, policy, and market analysis at the proper level. Resource constraints and infrastructure - high-quality, practical education requires expensive equipment (e.g., laboratories, simulation software)

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that is lacking in many institutions, especially in developing regions. Students often struggle to understand the complexity of energy systems and technical terminology, which requires improving visual and active teaching methods. Mismatch between industry and academia: There is a significant gap between the skills taught in academic circles and the skills required by the modern energy workforce, creating a need for more industry-specific curricula. The future of energy education lies in forming a "smart" energy workforce capable of adapting to both new technological advancements and the urgent need for a sustainable transition.

Proposals for solving these problems have been developed, the first of which is: creating digital educational platforms for energy sciences - an integrated learning environment based on the Internet that connects teacher and student in a single system, providing lesson materials, virtual laboratories, tests, simulators, and interaction opportunities. Through such systems, the student works in an environment close to practice, learns new technologies, and develops analytical and technical thinking. Second: organizing professional development and training courses for teachers in digital pedagogy - this is a new pedagogical approach aimed at organizing, managing, and evaluating the educational process based on modern information and communication technologies. The main goal of organizing these courses is to enhance the digital literacy of teachers, teach effective integration of ICT tools into the educational process, and teach teaching methodologies in distance and blended learning. Equipping energy laboratories with digital models and simulators will create safe and cost-effective conditions for gaining practical experience, allowing individual work for each student, conducting experiments without equipment failure or losses, and enabling automatic analysis and evaluation of learning outcomes.

As a result of strengthening research elements in education by teaching students to create 3D models, students develop creative and scientific thinking, the digital environment and virtual experiences expand in the educational process, and the

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quality and efficiency of research work increase. As a result of the modernization of practice bases in cooperation with energy enterprises, students will study the production process in real conditions, personnel with practical experience will be trained for energy enterprises, and constant innovative cooperation will be established between the educational institution and the enterprise.

Conclusion

In conclusion, the effective use of modern pedagogical approaches in teaching the energy sector is the most important factor in improving the quality of education. Innovative technologies, virtual laboratories, and 3D modeling tools make the educational process more effective, interesting, and practical. In the future, problems in the energy sector can be solved by digitalizing education and training teachers in modern methods. The application of modern pedagogical approaches in teaching the energy sector serves to raise the quality of education to a new level, enhance students' professional training, and train competitive specialists in the field. Teaching using technology not only provides knowledge but also makes a significant contribution to the formation of practical skills and critical thinking. The successful development of the energy sector requires the widespread application of modern educational methods. The role of pedagogy is of decisive importance in the development of the energy sector. Through the application of modern educational methods, teaching methodologies, and the development of scientific approaches, it is possible to train highly qualified, new-technology, and responsible energy specialists.

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