выступают неотъемлемым инструментом повышения качества образовательного процесса и его соответствия запросам общества и рынка труда.

Инновационные подходы, ориентированные на личностно–ориентированное, компетентностное и деятельностное обучение, способствуют формированию у обучающихся ключевых и профессиональных компетенций, развитию самостоя–тельности, критического мышления и способности к непрерывному обучению. Эффективные педагогические практики, основанные на активных методах обучения, проектной и исследовательской деятельности, а также использовании цифровых технологий, повышают мотивацию обучающихся и практическую значимость получаемых знаний.

Особая роль в реализации инноваций принадлежит педагогическому кол–лективу, профессиональная готовность и инновационная культура которого опреде–ляют успешность образовательных преобразований. Несмотря на наличие проблем, связанных с ресурсным обеспечением и уровнем подготовки педагогов, перспективы внедрения инновационных практик остаются значительными при условии системного подхода, методической поддержки и непрерывного профессионального развития.

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ARTIFICIAL INTELLIGENCE IN TRAINING SPECIALISTS OF AGRIBUSINESS POWER ENGINEERING WITHIN DIGITAL TRANSFORMATION

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Abstract

This article analyzes the possibilities and prospects of implementing artificial intelligence (AI) technologies in the training of highly qualified specialists of agribusiness power engineering. The urgent need to digitally modernize education curricula considering modern challenges in the energy sector is substantiated. Specific AI tools, such as intelligent tutoring systems and machine learning–based simulators, which contribute to improving the quality of practice–oriented education, are considered. It is demonstrated that AI integration allows for the creation of personalized educational pathways and effectively develops critical thinking of the future electrical engineers in the field of agribusiness.

Key words: *artificial intelligence; energy; digitalization of education; personalized learning; machine learning; intelligent simulators.*

Андатпа

Бұл мақалада агроөнеркәсіптік кешендегі жоғары білікті энергетика мамандарын даярлауға жасанды интеллект (ЖИ) технологияларын интеграциялаудың мүмкіндіктері мен болашағы талданады. Энергетика саласының қазіргі қиындықтарын ескере отырып, білім беру бағдар–ламаларын цифрлық түрлендіру қажеттілігі негізделеді. Тәжірибеге бағытталған оқыту сапасын жақсартуға ықпал ететін интеллектуалды оқыту жүйелері мен машиналық оқытуға негізделген симуляторлар сияқты нақты ЖИ құралдары талқыланады. ЖИ интеграциясы жекелендірілген білім беру жолдарын құруға мүмкіндік беретіні және агроөнеркәсіптік кешендегі болашақ энергетика мамандарында сыни ойлауды тиімді дамытатыны дәлелденген.

Түйінді сөздер: *жасанды интеллект; энергетика; білім беруді цифрландыру; жекелен–дірілген оқыту; машиналық оқыту; интеллектуалды симуляторлар*

Аннотация

Настоящая статья посвящена анализу возможностей и перспектив внедрения технологий искусственного интеллекта (ИИ) в процесс подготовки высококвалифицированных специалистов–энергетиков агропромышленного комплекса. Обоснована необходимость цифровой трансфор–мации образовательных программ в свете современных вызовов энергетической отрасли. Рассмотрены конкретные инструменты ИИ, такие как интеллектуальные обучающие системы и симуляторы на базе машинного обучения, способствующие повышению качества практико–ориентированного обучения. Доказано, что интеграция ИИ позволяет создать персонали–зированные образовательные траектории и эффективно развивать критическое мышление у будущих энергетиков АПК.

Ключевые слова: *искусственный интеллект; энергетика; цифровизация образования; персонализированное обучение; машинное обучение; интеллектуальные симуляторы.*

In the context of the rapid modernization of the energy complex and the transition to the global paradigm of "Industry 4.0", the justification for the necessity of a deep digital transformation of the professional education system is becoming especially significant. The energy sector, as a critical infrastructure, is undergoing revolutionary changes driven by the implementation of "Smart Grids" technologies [3].

Smart Grids, characterized by the two–way transmission of energy and information, require future specialists in the field of agribusiness power engineering to possess not only fundamental theoretical knowledge but also professional competencies that allow them to flexibly adapt to the conditions of a highly automated operational environment [3]. That’s why higher technical educational institutionshave to train young professionals who are proficient in modern pedagogical technologies and, crucially, capable of effectively managing and optimizing the operation of complex distributed systems.

In this regard, the relevance of this study is determined by the urgent need to develop and implement new models and forms of teaching process that combine academic preparation with the real professional activities of future engineers. The central tool in addressing this challenge is Artificial Intelligence (AI).

The Aim of the Article: To substantiate the methodological approaches and identify the practical possibilities of using Artificial Intelligence technologies to improve the quality and practical orientation of training future electrical engineers in the context of digital transformation.

Research Objectives:

1. To analyze the competency requirements for energy specialists in the context of Smart Grid development.

2. To substantiate the role of AI as a tool for creating adaptive and personalized educational pathways.

3. To consider the practical application of AI tools (simulators, intelligent systems) for developing real–time decision–making skills.

The transition to the "Smart Grids" concept requires operational personnel to possess skills for working with highly dynamic and unpredictable systems. Traditional static simulators, which are based on predefined algorithms, are unable to fully prepare a specialist for conditions of uncertainty and information overload. Intelligent Simulators, built on Machine Learning technologies and Digital Twinsare central to this approach. [1].

The main advantage of AI simulators (in contrast to conventional static ones) in training a power system operator lies in their ability to autonomously and dynamically generate and modify scenarios depending on the actions of the trainee [1]. AI allows for modeling rare and critical emergency situations that are difficult or dangerous to reproduce in real life (e.g., cascading blackouts, cyberattacks); adapting the complexity and pace of training in real–time, simulating the reaction of a real power system to the specialist's actions (rather than merely following a rigid script) and ensuring multi–factor influence (weather conditions, demand fluctuations, sudden sensor failures), which brings the learning environment closer to real production conditions.

Thus, AI simulators do not just repeat pre–programmed situations; they create an adaptive, realistic space for developing decision–making skills under stress and time deficit. The impact of such systems on developing competencies is significantly higher compared to traditional methods, which is confirmed by the data from the comparative analysis of training results (see Figure 1).

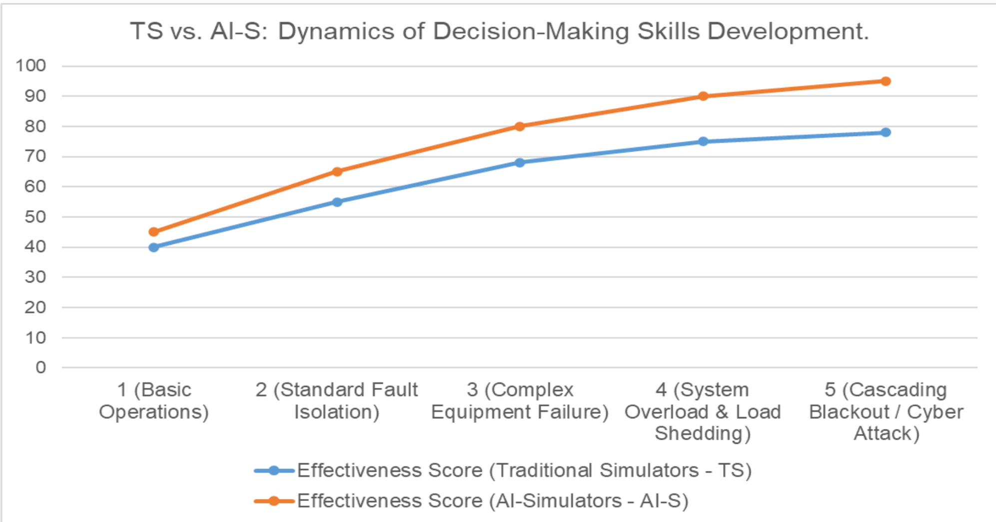

Figure 1 – Dynamics of Key Competency Formation (Decision–Making Skills) for an Energy Specialist using Traditional (TS) and AI–Oriented (AI–S) Training Methods.

The second key area for AI application is the provision of personalized learning trajectories [2, 4]. Traditional education often uses a one–size–fits–all approach, which fails to account for the individual learning speed and specific knowledge gaps of future specialists. AI–driven platforms, utilizing learning analytics and diagnostic tools, can precisely identify the points of failure in a student’s fundamental knowledge [4].

For future specialists in the field of agribusiness power engineering, foundational weakness frequently arises in areas critical for the operation of Smart Grids, such as:

1. Theoretical Foundations of Electrical Engineering (TFEE): Weak understanding of transient processes, complex circuit analysis, and electromagnetism, which are essential for modeling modern grid behavior.

2. Applied Programming and Automation: Deficiencies in skills related to programming industrial controllers and configuring SCADA systems, which are essential for highly automated substations and renewable energy integration. The Intelligent Tutoring Systems based on AI solve this problem by [5]:

– Real–time Diagnostics: Analyzing student performance in quizzes, practical tasks, and simulations to precisely identify the module or subtopic requiring correction.

– Targeted Gap Remediation: Automatically generating personalized assignments, micro–lessons, or specialized modules to close the identified gap, thus preventing the accumulation of knowledge deficits.

– Adaptive Pacing: Allowing students to master foundational subjects at their individual speed before advancing to complex, application–specific disciplines (e.g., relay protection or grid optimization).

The effectiveness of this diagnostic and corrective approach is illustrated in Table 1, which compares the average number of additional hours of in–class learning required for students to achieve a predefined mastery level in key foundational subjects using traditional and AI–driven methods.

Table 1. Comparative Analysis of Time Spent on Remedial Teaching for Foundational Subjects (Average additional hours per student).

Foundational Subject (Knowledge Gap)	Traditional Teaching (Tutor / Group Classes) (Hours)	AI–Driven Personalized Remediation (Hours)	Time Reduction (%)
Complex Circuit Analysis (TFEE)	15	6	60 %
Differential Equations (Mathematics)	12	5	58 %
PLC Programming Principles	20	8	60 %
Average Efficiency Gain	15,7	6,3	59,3 %

Traditional knowledge control methods often suffer from subjectivity and an inability to adequately assess practical decision–making skills under stressful conditions. In training specialists for Smart Grids, it is critical to assess not only "knowing" but also "being able to act".

Artificial intelligence allows for a radical increase in the objectivity and validity of assessment by performing the following functions [5]:

– Analysis of Implicit Parameters: AI systems embedded in Digital Twin simulators can analyze not only the final outcome of the operator's action but also the decision–making process: reaction time, number of unnecessary switching operations, sequence of steps, and even the emotional state (through analysis of voice commands or cursor movements).

– Comparison with Reference Models: The AI compares the trainee's actions against an optimal algorithm (expert model) created based on the experience of leading industry specialists, providing a precise, unbiased report on discrepancies.

The highest efficiency is achieved when assessment is no longer a separate event (an exam) but becomes a continuous process integrated into the learning trajectory [5].

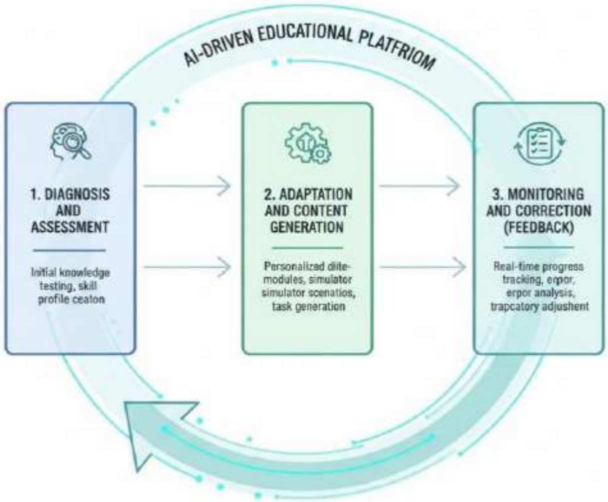

Figure 2 – Methodological Scheme for Integrating Artificial Intelligence into the Training Process of future specialists in the field of agribusiness power engineering based on Adaptive Learning Trajectories.

As shown in Figure 2, the methodological scheme for AI integration involves constant monitoring and correction. This means the AI platform not only teaches but also continuously assesses the student at every stage:

– Current Control: Evaluation of the complexity of the material mastered and the speed of module completion.

– Intermediate Control: Assessment of effectiveness in simulator scenarios.

– Final Control: Comprehensive testing of all competencies in an AI–generated scenario.

This cyclical model ensures the transparency of the learning process for both the student and the instructor, providing a detailed "digital footprint" of competency acquisition.

Based on the conducted analysis, it can be asserted that the integration of Artificial Intelligence technologies into the educational process for training future specialists is not merely a modernization but a strategic necessity to meet the requirements of the "Smart Grids" concept and the transition to Industry 4.0.

The main conclusions of the study are as follows:

1. Enhanced Practical Training: The use of Intelligent Simulators and Digital Twins, powered by AI, allows for a shift from the static reproduction of scenarios to dynamic, adaptive modeling. This is crucial for developing operational personnel's decision–making skills under uncertainty and during the occurrence of rare, cascading faults, which is unattainable through traditional methods [1] (see Figure 1).

2. Effective Gap Remediation: AI systems provide personalized learning, effectively identifying and specifically addressing gaps in fundamental knowledge (e.g., in Theoretical Foundations of Electrical Engineering and higher mathematics). This approach significantly reduces the total time required to achieve the necessary competency level, thereby increasing the overall effectiveness of the educational process [2, 4] (see Table 1).

3. Assessment Objectivity: AI ensures the transparency and objectivity of competency assessment. By analyzing not only the final result but also the student's decision–making process (reaction time, sequence of actions) in simulation environments,

AI provides unbiased feedback, which forms the basis for a continuous learning and correction cycle [5] (see Figure 2).

4. Comprehensive Transformation: The methodological scheme for AI integration into education provides a cyclical, adaptive process that combines diagnosis, an individual trajectory, and continuous monitoring. This allows higher technical education institutions to rapidly train future specialists who possess not only theoretical knowledge but also the practical skills required in the highly automated energy sector.

Thus, AI is a key factor in ensuring the formation of highly qualified, adaptive specialists capable of effectively managing the complex and dynamic systems of the modern energy complex.

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УДК 377.1

ОТНОШЕНИЕ ОБУЧАЮЩИХСЯ ТЕХНИЧЕСКОГО ВУЗА К ИСПОЛЬЗОВАНИЮ ИСКУССТВЕННОГО ИНТЕЛЕКТА В ВЫСШЕМ ОБРАЗОВАНИИ

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Аннотация

В статье представлен анализ результатов опроса студентов Национального исследовательского Московского государственного строительного университета. Целью опроса было выяснить отношение обучающихся к внедрению технологий искусственного интеллекта в образовательный процесс. По результатам опроса большинство обучающихся позитивно оценивают применение искусственного интеллекта в обучении, поскольку это позволяет экономить время на выполнение учебных работ. Тем не менее, студенты выражают обеспокоенность увеличением объемов академического мошенничества.

Ключевые слова: *искусственный интеллект, академическое мошенничество, критическое мышление, индивидуализация образования, нейросети.*