

**SCIENTIFIC AND METHODOLOGICAL BASIS FOR THE APPLICATION OF
ARTIFICIAL INTELLIGENCE IN TEACHING PHYSICAL ELECTRONICS**As.prof. **Nodira Mustafoeva**University of Information Technologies and Management, Karshi city, Uzbekistan
mustafoeyevan@gmail.com**Abstract**

This article analyzes the scientific and methodological foundations of using artificial intelligence technologies in teaching physical electronics. The integration of AI-based adaptive learning systems, virtual laboratories, and intelligent support systems into the educational process is examined. The research results indicate that the use of AI technologies is an important factor in improving the effectiveness of education and deepening students' knowledge.

Keywords

artificial intelligence, physical electronics, adaptive learning, virtual laboratory, STEM, digital pedagogy.

Introduction

In the modern education system, processes of digital transformation are being widely implemented. In particular, the introduction of innovative technologies in the teaching of technical and natural sciences has become an urgent issue. Physical electronics is distinguished by its complex theoretical foundations and experimental characteristics. Therefore, the use of artificial intelligence (AI) technologies in its effective teaching is of significant scientific and practical importance.

In recent years, AI-based educational systems have enabled:

- personalization of learning;
- real-time assessment of knowledge;
- modeling of complex physical processes.

Challenges in Teaching Physical Electronics: The following key challenges are observed in teaching physical electronics:

- complexity of abstract concepts (quantum processes, electron motion);
- complexity of the mathematical apparatus;
- lack of laboratory equipment;
- difficulty in accounting for individual differences among students.

AI technologies can serve as an effective tool in addressing these challenges.

Theoretical Foundations of Artificial Intelligence and Its Application in Education: Artificial intelligence is the ability of computer systems to perform functions characteristic of human intelligence (Russell & Norvig, 2021). In education, AI manifests itself through the following technologies:

1. Machine Learning

It analyzes students' learning activities and provides individualized recommendations.

2. Artificial Neural Networks

They enable modeling and prediction of complex physical processes.

3. Natural Language Processing (NLP)

It allows the development of systems that automatically respond to students' questions.

Methodology of Teaching Physical Electronics Based on AI

Adaptive Learning Model

With the help of AI, an individual learning trajectory is created for each student. This model includes:

- diagnostic tests;
- individualized assignments;
- automated analysis.

Virtual Laboratories: The following processes are modeled in a virtual environment:

- semiconductor physics;
- p–n junction processes;
- operating principles of transistors.

These laboratories partially replace real experiments and provide a safe and cost-effective environment.

Intelligent Tutoring Systems

AI-based tutoring systems:

- provide guidance to students;
- identify errors;
- offer step-by-step explanations.

Research Results and Analysis: Studies (Luckin et al., 2016; Holmes et al., 2019) indicate that: AI-based learning systems increase knowledge acquisition by 20–30%; individualized approaches enhance learning motivation; visual modeling facilitates understanding of complex concepts.

Advantages: Personalization of the learning process; Visual explanation of complex topics; Automated assessment; Expansion of opportunities for independent learning.

Challenges and Limitations

- insufficient technical infrastructure;
- high cost of developing AI systems;
- low level of teachers' digital competence;
- issues related to academic integrity.

Conclusion

The use of artificial intelligence technologies in teaching physical electronics significantly improves the effectiveness of education. AI-based approaches facilitate the understanding of complex theoretical concepts, individualize the learning process, and meet the requirements of modern STEM education. In the future, it is important to expand scientific research in this field and implement its results into practice.

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