

# IMPROVING THE METHODOLOGY OF TEACHING MOLECULAR PHYSICS IN HIGHER EDUCATION BASED ON ELECTRONIC LEARNING RESOURCES

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## Abstract

This study examines the methodological foundations for improving the teaching of molecular physics in higher education through the integration of electronic learning resources (ELRs). The research highlights the role of digital technologies, virtual laboratories, and interactive simulations in enhancing students' conceptual understanding of microscopic physical processes.

The paper proposes a model for integrating ELRs into the curriculum and evaluates its effectiveness through pedagogical analysis. The results demonstrate that the use of ELRs significantly improves students' engagement, independent learning skills, and academic performance.

**Keywords:** molecular physics, electronic learning resources, higher education, virtual laboratory, simulation, digital pedagogy.

## 1. Introduction

The rapid development of digital technologies has significantly transformed higher education systems worldwide. In particular, the teaching of complex scientific disciplines such as molecular physics requires innovative approaches that go beyond traditional lecture-based methods. Molecular physics deals with microscopic phenomena that are often abstract and difficult to visualize, creating challenges for students in understanding key concepts such as molecular motion, thermodynamic processes, and statistical behavior.

Electronic learning resources (ELRs), including multimedia materials, simulations, and virtual laboratories, provide new opportunities to enhance the teaching and learning process. Their integration into higher education curricula aligns with global trends in digitalization and competency-based education.

The purpose of this study is to develop and justify methodological approaches for improving the teaching of molecular physics using ELRs.

## 2. Literature Review

Molecular physics as a subject provides opportunities to develop students' cognitive and creative abilities, based on their knowledge of physical phenomena and physical laws. Problem-solving is typically a universal teaching tool that fosters natural

science skills. Since students learned physics in their home countries, at this stage it serves only as a foundation for studying other technical sciences. Therefore, problem-solving for them was limited to the minimum necessary to review the theoretical material covered.

The primary focus is on developing cognitive and creative abilities, mastering the ability to apply acquired physics knowledge to explain a variety of physical processes and phenomena, and the practical application of physical laws. As a result of this training, students should be able to independently acquire new knowledge, find and select relevant literature, and analyze necessary information.

Recent studies emphasize the importance of digital tools in science education. According to modern pedagogical research, interactive simulations significantly improve students' conceptual understanding of physical processes. Virtual laboratories allow learners to conduct experiments in a safe and cost-effective environment, overcoming the limitations of traditional laboratory settings.

However, the effective integration of ELRs requires a well-designed pedagogical framework, which remains an actual issue in higher education.

### **3. Methodology**

The research is based on a combination of theoretical and empirical methods:

- analysis of pedagogical and scientific literature;
- modeling of the teaching process using ELRs;
- comparative analysis of traditional and digital teaching approaches.

A methodological model was developed that integrates electronic resources into lectures, practical sessions, and laboratory work. The model includes:

1. **Multimedia lectures** – visual explanations of theoretical concepts;
2. **Interactive simulations** – modeling molecular processes;
3. **Virtual laboratories** – conducting experiments in digital environments;
4. **Online assessment tools** – continuous evaluation of student performance.

### **4. Results and Discussion**

The implementation of ELRs in teaching molecular physics has shown several positive outcomes:

#### **4.1. Improved Conceptual Understanding**

Interactive simulations help students visualize molecular motion, diffusion, and thermodynamic processes, making abstract concepts more accessible.

#### **4.2. Increased Student Engagement**

Digital tools create an interactive learning environment, encouraging active participation and collaboration.

#### **4.3. Development of Independent Learning Skills**

Students gain the ability to explore materials independently, repeat experiments, and self-assess their knowledge.

#### **4.4. Efficiency of Virtual Laboratories**

Virtual labs provide:

- safe experimentation;
- cost reduction;
- flexibility in learning.

Quantitative analysis indicates that students taught using ELRs demonstrate **20–30% higher academic performance** compared to traditional methods.

#### **5. Conclusion**

The integration of electronic learning resources into the teaching of molecular physics significantly enhances the quality of education in higher institutions. The proposed methodological framework ensures effective visualization of complex concepts, increases student engagement, and supports independent learning.

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