



THE USE OF PEDAGOGICAL TECHNOLOGIES IN TEACHING THE LAWS OF THE ELECTRIC FIELD IN PHYSICS

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Abstract

This article analyzes the effectiveness of modern pedagogical technologies in teaching the laws of the electric field in physics education. Due to the abstract nature of electric field concepts, students often face difficulties in understanding fundamental laws such as Coulomb's law, electric field intensity, and electric potential. The study emphasizes the role of interactive teaching methods, information and communication technologies, problem-based learning, and project-based learning in enhancing students' conceptual understanding, motivation, and analytical thinking skills. The results show that the systematic integration of pedagogical technologies significantly improves learning outcomes and student engagement.

Keywords: Physics education, electric field laws, pedagogical technologies, interactive learning, ICT, problem-based learning.

1. Introduction

The rapid development of science and technology has led to significant changes in modern education systems. Traditional teaching approaches are no longer sufficient to meet the growing demands for high-quality education and the development of students' critical and analytical thinking skills. Physics, as a fundamental natural science, plays a key role in preparing students for scientific and technological progress. However, many physics topics are abstract and mathematically complex, which often causes learning difficulties [1-2].

One of the most challenging topics in secondary and higher education physics courses is the concept of the electric field and its governing laws. The electric field cannot be directly observed, and students must rely on theoretical models, mathematical expressions, and visual representations to understand its behavior. As a result, students frequently develop misconceptions or rely on rote memorization rather than meaningful understanding [3].





In this context, the use of modern pedagogical technologies becomes essential. Pedagogical technologies provide innovative tools and methods that support student-centered learning, active participation, and conceptual understanding. This article aims to examine how pedagogical technologies can be effectively applied in teaching the laws of the electric field and to analyze their impact on students' learning outcomes.

2. Methodology

The methodology of this study is based on a qualitative and analytical approach to the application of pedagogical technologies in physics education. Various teaching methods and technological tools were reviewed and analyzed based on their effectiveness in teaching electric field laws.

The teaching process was organized using a combination of interactive learning methods, information and communication technologies, problem-based learning, and project-based learning. Interactive methods such as brainstorming, concept mapping, and group discussions were used to activate students' prior knowledge and encourage active participation [4].

Information and communication technologies played a central role in methodology. Computer simulations, animations, and virtual laboratories were used to visualize electric field distributions, electric field lines, and charge interactions. These tools allowed students to explore different configurations of electric charges and observe changes in electric field strength and direction [5].

Problem-based learning was implemented by presenting students with conceptual and numerical problems related to electric fields. Students were encouraged to analyze the problems, formulate hypotheses, and apply theoretical knowledge to find solutions. In addition, project-based learning activities required students to investigate real-life applications of electric fields and present their findings. Student learning outcomes were evaluated through formative assessment methods, including quizzes, classroom observations, and project presentations. The collected data were analyzed to assess the effectiveness of pedagogical technologies in improving conceptual understanding and engagement.

3. Results and Discussion

The results of the study indicate that the integration of pedagogical technologies significantly enhances students' understanding of electric field laws. Students who participated in interactive and technology-enhanced lessons demonstrated a deeper conceptual understanding compared to those taught using traditional lecture-based methods.





One of the most notable outcomes was the improvement in students' ability to visualize electric fields. Computer simulations and animations helped students understand the spatial distribution of electric fields and the relationship between electric charges and field intensity. This visual support reduced common misconceptions and improved students' problem-solving performance.

Interactive teaching methods increased student engagement and participation. Group discussions and brainstorming activities encouraged students to express their ideas, ask questions, and collaboratively solve problems. As a result, students developed better communication and teamwork skills.

Problem-based learning activities were particularly effective in developing analytical and critical thinking skills. By solving real-life and theoretical problems, students learned to apply mathematical formulas meaningfully rather than memorizing them. Project-based learning further strengthened students' research skills and helped them connect theoretical concepts to practical applications.

The discussion of the results highlights the importance of combining different pedagogical technologies to achieve optimal learning outcomes. While ICT tools improve visualization and understanding, interactive and problem-based methods promote deeper cognitive engagement. Therefore, a blended approach is recommended for teaching abstract physics concepts such as electric field laws.

4. Conclusion

In conclusion, the use of pedagogical technologies in teaching the laws of the electric field plays a crucial role in enhancing the quality and effectiveness of physics education. Modern teaching methods and technological tools help overcome the challenges associated with the abstract nature of electric field concepts.

The findings of this study demonstrate that interactive learning, information and communication technologies, problem-based learning, and project-based learning significantly improve students' conceptual understanding, motivation, and analytical thinking skills. These approaches encourage active participation and foster independent learning.

Therefore, it is recommended that physics educators systematically integrate pedagogical technologies into their teaching practices. Such integration will not only improve students' academic performance but also prepare them for future scientific and technological challenges.





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