ISSN 2663-8169 Vol. 7, Issue 4: 30-35, DOI: 10.25236/IJNDE.2025.070405

Research on Big Data-Assisted University Physics Teaching under Artificial Intelligence

Gao Huiping

Qingdao Huanghai University, Qingdao, Shandong, 266427, China

Abstract: *Against the backdrop of the rapid development of artificial intelligence technology, big data-assisted teaching methods have brought new changes to university physics teaching. This study explores how to leverage big data technology and artificial intelligence algorithms to optimize the process of university physics teaching and enhance teaching efficiency and quality. By analyzing multidimensional data such as student learning behavior data, physics experiment data, and teaching effectiveness feedback, combined with artificial intelligence techniques such as machine learning and deep learning, we have constructed a personalized learning recommendation system, an intelligent evaluation and feedback mechanism, and an intelligent assistance platform for physics experiments. These innovative applications not only help teachers accurately grasp students' learning status and achieve differentiated teaching but also stimulate students' interest in learning and enhance their autonomous learning abilities. Practical results show that the integration of big data and artificial intelligence significantly improves the pertinence and effectiveness of university physics teaching, providing strong support for the modernization of physics education.*

Keywords: *artificial intelligence; big data; university physics teaching; personalized learning; intelligent evaluation; physics experiment assistance*

1. Introduction

With the rapid development of artificial intelligence technology, the application trend of big data in the field of education has become increasingly prominent, providing powerful impetus for the innovation and transformation of educational models. As an important part of higher education, university physics teaching faces multiple challenges, including improving teaching efficiency and quality, stimulating students' interest and innovative abilities. Against this backdrop, this study aims to delve into how big data and artificial intelligence can effectively optimize university physics teaching and explore specific pathways to enhance teaching efficiency and quality. By integrating advanced artificial intelligence algorithms with big data analysis techniques, we hope to inject new vitality into university physics teaching and promote its development towards a more intelligent and personalized direction. This study not only holds significant theoretical value but also provides strong support for the practical reform of university physics teaching, contributing to the cultivation of more high-quality talents with innovative spirits and practical abilities.

2. Application Framework of Big Data and Artificial Intelligence in College Physics Teaching

2.1 Overview of the Application Framework

2.1.1 Data Collection and Processing Layer

In this layer, the primary focus is on how to effectively collect and process various types of data related to college physics teaching. Data collection encompasses multiple dimensions such as students' learning behavior data, physics experiment data, teaching resource data, and feedback on teaching effectiveness. These data are stored and managed using big data platforms and database technologies to ensure data integrity, accuracy, and security. The processing layer is responsible for cleaning, integrating, and analyzing these raw data to extract valuable information, providing data support for subsequent artificial intelligence algorithm applications. Through the work of this layer, a comprehensive and accurate data foundation can be established, providing a strong guarantee for optimizing college physics teaching.

ISSN 2663-8169 Vol. 7, Issue 4: 30-35, DOI: 10.25236/IJNDE.2025.070405

2.1.2 Artificial Intelligence Algorithm Application Layer

Based on data collection and processing, the artificial intelligence algorithm application layer becomes the core of the entire framework. This layer primarily utilizes machine learning and deep learning algorithms to conduct in-depth mining and analysis of the processed data. By building models and training algorithms, functions such as precise prediction of students' learning status, personalized learning resource recommendations, and intelligent assessment of teaching effectiveness can be achieved. Additionally, natural language processing and image recognition technologies are also widely applied in this layer to enable intelligent parsing and processing of text and image data, further enhancing the accuracy and practicality of the algorithms[1].

2.1.3 Teaching Application and Feedback Layer

The teaching application and feedback layer serves as a bridge connecting artificial intelligence algorithms with actual teaching scenarios. In this layer, intelligent recommendations and assessment results generated by the algorithm application layer are converted into specific teaching strategies and tools, such as personalized learning path planning, intelligent tutoring systems, and intelligent analysis platforms for experimental data. At the same time, a comprehensive feedback mechanism is established to continuously optimize algorithms and application effects by collecting feedback from students and teachers. The work of this layer aims to convert the advantages of artificial intelligence technology into actual teaching achievements, improving the quality and efficiency of college physics teaching.

2.2 Key Technologies and Tools

2.2.1 Big Data Platforms and Database Technologies

Big data platforms and database technologies form the foundation supporting the entire application framework. They are responsible for storing and managing vast amounts of teaching data, ensuring data reliability, security, and scalability. By adopting technologies such as distributed storage and parallel computing, big data platforms can efficiently process and analyze large-scale datasets, providing robust support for subsequent algorithm applications. Database technologies, on the other hand, handle data organization, storage, and retrieval, ensuring data accuracy and consistency.

2.2.2 Machine Learning and Deep Learning Algorithms

Machine learning and deep learning algorithms are the core technologies of artificial intelligence applications. They achieve intelligent analysis and prediction of data by building models and training algorithms. In college physics teaching, these algorithms are widely used in personalized learning recommendations, teaching effectiveness assessments, intelligent analysis of experimental data, and other areas. By continuously optimizing algorithm models, we can improve prediction accuracy and practicality, providing a scientific basis for teaching decisions[2].

2.2.3 Natural Language Processing and Image Recognition Technologies

Natural language processing (NLP) and image recognition technologies are two important branches in the field of artificial intelligence. They are responsible for intelligent parsing and processing of text and image data, respectively. In college physics teaching, these technologies are widely applied in intelligent retrieval of teaching resources, automatic grading of experimental reports, intelligent analysis of physics experimental data, and other aspects. By incorporating these technologies, we can further enhance teaching efficiency and accuracy, providing students with a more convenient and efficient learning experience.

3. Construction of a Personalized Learning Recommendation System

3.1 System Design Principles and Objectives

3.1.1 Student-Centered Approach to Meet Individual Learning Needs

From the outset of system design, we adhere to a student-centered approach, dedicated to meeting students' individual learning needs. This means the system must be able to identify and understand each student's learning style, interests, and knowledge level, thereby providing tailored learning resources and paths. By deeply analyzing students' learning behavior data, we can more accurately grasp their learning characteristics and needs, and subsequently recommend the most suitable learning content and methods to them, promoting their overall development[3].

ISSN 2663-8169 Vol. 7, Issue 4: 30-35, DOI: 10.25236/IJNDE.2025.070405

3.1.2 Data-Driven for Precise Recommendations

Another important objective of system design is to achieve precise recommendations based on data. By utilizing big data technologies and machine learning algorithms, we deeply mine and analyze students' learning behavior data to reveal patterns and trends. Through these data, we can predict students' learning needs and potential issues, and accordingly provide them with precise recommendations and solutions. This data-driven recommendation approach not only improves the accuracy and effectiveness of recommendations but also provides students with a more personalized and intelligent learning experience.

3.2 System Functional Modules

3.2.1 Learning Behavior Analysis Module

The Learning Behavior Analysis Module is one of the core components of the system. It is mainly responsible for collecting, organizing, and analyzing students' learning behavior data, including study time, learning progress, learning outcomes, and other aspects. Through in-depth analysis of these data, we can understand students' learning habits, interests, and potential learning issues, providing data support for subsequent knowledge graph construction and personalized resource recommendations.

3.2.2 Knowledge Graph Construction Module

The Knowledge Graph Construction Module is key to the system's ability to provide personalized learning recommendations. Based on students' learning behavior data and domain knowledge, it constructs a comprehensive and systematic knowledge graph. This graph not only contains the relationships between various knowledge points but also reflects students' learning paths and interests. Through the knowledge graph, we can more intuitively understand students' learning status and needs, providing them with more precise and effective learning resources and paths.

3.2.3 Personalized Resource Recommendation Module

The Personalized Resource Recommendation Module is the functional part of the system that directly faces students. Based on the output results of the Learning Behavior Analysis Module and Knowledge Graph Construction Module, it recommends personalized learning resources to students. These resources include course videos, learning materials, practice exercises, and other aspects, aiming to meet students' different learning needs and interests. Through personalized resource recommendations, students can more efficiently acquire the knowledge they need, improving their learning efficiency and satisfaction[4].

3.3 Implementation Strategies and Expected Outcomes

3.3.1 Dynamically Adjust Recommendation Strategies to Adapt to Student Changes

During implementation, dynamically adjusting recommendation strategies will be adopted to adapt to changes in students. As students' learning needs and interest preferences may change over time, it is necessary to regularly update the data in the Learning Behavior Analysis Module and Knowledge Graph Construction Module, and adjust recommendation strategies accordingly. In this way, the system can ensure that it always provides students with learning resources and paths that best meet their current needs.

3.3.2 Enhance Students' Learning Motivation and Engagement

It is expected that through the implementation of the system, students' learning motivation and engagement will be significantly enhanced. By providing personalized learning resources and paths, students' interest in learning and curiosity can be stimulated, making them more proactive in participating in the learning process. At the same time, functions such as precise recommendations and intelligent tutoring can help students solve difficulties and problems in their learning, improving their learning efficiency and sense of accomplishment. These will all contribute to enhancing students' learning motivation and engagement, promoting their comprehensive development.

ISSN 2663-8169 Vol. 7, Issue 4: 30-35, DOI: 10.25236/IJNDE.2025.070405

4. Innovation in Intelligent Evaluation and Feedback Mechanisms

4.1 Evaluation Indicators and Methodology

4.1.1 Construction of a Multidimensional Evaluation System

In educational evaluation, a single-dimensional evaluation often fails to comprehensively reflect teaching effectiveness. Therefore, a multidimensional evaluation system has been constructed to evaluate students' learning outcomes from multiple perspectives, including the degree of knowledge mastery, learning skills improvement, changes in learning attitude, and innovation ability cultivation. This system not only focuses on students' learning outcomes but also attaches importance to their performance and development during the learning process. By comprehensively utilizing various evaluation methods such as questionnaires, test scores, project assignments, and classroom participation, a more comprehensive understanding of students' learning situations can be obtained, providing strong support for subsequent teaching improvements.

4.1.2 Combination of Real-time and Delayed Evaluation

To more accurately grasp students' learning dynamics, a combination of real-time and delayed evaluation is adopted. Real-time evaluation mainly focuses on immediate feedback during the learning process, such as classroom interaction and online testing, allowing teachers to adjust teaching strategies in a timely manner. Delayed evaluation emphasizes long-term tracking and evaluation of learning outcomes, such as final exams and project reports, to reflect students' overall learning effectiveness. By combining these two evaluation methods, a more comprehensive understanding of students' learning progress and effectiveness can be obtained, providing data support for continuous improvement in teaching quality.

4.2 Design of Feedback Mechanisms

4.2.1 Immediate Feedback and Regular Summative Feedback

In the design of feedback mechanisms, emphasis is placed on the combination of immediate feedback and regular summative feedback. Immediate feedback allows students to obtain timely feedback on their learning situations during the learning process, thereby adjusting their learning strategies and improving learning efficiency. Regular summative feedback is a comprehensive review and summary of students' learning outcomes, helping them clarify their learning progress and existing problems, and formulate clearer goals and plans for subsequent learning. The combination of these two feedback methods can more effectively promote students' autonomous learning and continuous improvement.

4.2.2 Combination of Personalized and Collective Feedback

To meet the diverse learning needs of students, a mechanism combining personalized and collective feedback has been designed. Personalized feedback provides targeted guidance and suggestions based on the specific circumstances of each student, helping them better understand their learning characteristics and issues. Collective feedback, on the other hand, addresses common problems within the entire class or a particular study group, providing overall guidance and suggestions to promote cooperation and collective progress within the class or group. The combination of these two feedback methods can more comprehensively meet students' learning needs and enhance the overall teaching quality of the class.

4.3 Facilitating Teaching Effectiveness

4.3.1 Enhancing Teacher-Student Interaction and Improving Teaching Relevance

By constructing a multidimensional evaluation system and designing effective feedback mechanisms, we can better understand students' learning situations and needs, thereby facilitating interaction between teachers and students. Teachers can adjust teaching strategies and content in a timely manner based on evaluation results and feedback, enhancing the relevance and effectiveness of teaching. At the same time, students can express their learning needs and confusion through the feedback mechanism and obtain more personalized guidance and assistance. This interaction not only contributes to improving teaching quality but also enhances students' learning motivation and engagement.

ISSN 2663-8169 Vol. 7, Issue 4: 30-35, DOI: 10.25236/IJNDE.2025.070405

4.3.2 Helping Students Identify Problems Promptly and Adjust Learning Strategies

An effective evaluation system and feedback mechanism enable students to promptly identify problems and deficiencies in their learning. Through immediate and regular summative feedback, students can gain a clearer understanding of their learning progress and existing issues, thereby adjusting their learning strategies and improving their learning methods in a timely manner. This process of self-reflection and adjustment helps students better master knowledge and skills, enhancing their learning effectiveness and grades. Additionally, through continuous experimentation and adjustment of learning strategies, students can develop their autonomous learning and problem-solving abilities, laying a solid foundation for future study and work.

5. Development of an Intelligent Assistance Platform for Physics Experiments

5.1 Platform Design Concept and Functional Orientation

When designing the physics experiment teaching platform, the design concept of "student-centered and emphasizing practical abilities" was followed. The design concept of the platform aims to create a comprehensive physics experiment learning environment integrating teaching, learning, evaluation, and feedback by integrating advanced digital technology and educational resources. In terms of functional orientation, the platform not only provides abundant physics experiment course resources but also features functions such as experiment reservation management, online experiment guidance, intelligent analysis of experiment data, tracking of learning progress, and personalized learning recommendations. Through these functions, the platform can effectively support students' autonomous learning, collaborative learning, and deep learning while helping teachers improve teaching efficiency and optimize the allocation of teaching resources[5].

5.2 Key Technological Innovations

The platform has made significant breakthroughs in technological innovation. Firstly, it introduces artificial intelligence and big data technologies to achieve real-time collection, intelligent analysis, and precise feedback of students' experimental data. This technology not only improves the processing efficiency of experimental data but also provides students with personalized learning suggestions to help them better understand and master experimental knowledge. Secondly, the platform adopts virtual reality (VR) and augmented reality (AR) technologies to provide students with an immersive experimental experience. By simulating real experimental environments and operating procedures, students can conduct experimental operations in a virtual environment, effectively reducing experimental risks and costs while enhancing the fun and interactivity of experimental teaching.

5.3 The Transformative Impact on Physics Experiment Teaching

The launch of this platform has had a profound transformative impact on physics experiment teaching. Firstly, it breaks the constraints of traditional physics experiment teaching, enabling students to engage in experimental learning and operations anytime and anywhere. This flexible learning mode not only improves students' learning efficiency but also provides them with more opportunities for autonomous learning and exploration. Secondly, through intelligent analysis and feedback functions, the platform helps students better understand and master experimental knowledge, enhancing their experimental skills and innovation capabilities. At the same time, teachers can also use the platform to gain real-time insights into students' learning progress and experimental situations, thereby providing more precise teaching guidance and evaluation.

6. Advantages and Challenges of Big Data and Artificial Intelligence in College Physics Teaching

6.1 Advantages Analysis

In the context of rapid advancements in educational technology, the constructed platforms or systems possess multiple significant advantages. Firstly, their highly integrated design enables the effective integration of various educational resources, forming a knowledge system that is rich in content and clearly structured. This integration not only simplifies the learning path but also enhances learning efficiency, enabling learners to master core knowledge and skills more quickly. Secondly, the

ISSN 2663-8169 Vol. 7, Issue 4: 30-35, DOI: 10.25236/IJNDE.2025.070405

platform adopts advanced technological means such as artificial intelligence and big data analysis to achieve the customization and intelligent recommendation of personalized learning paths. This personalized learning experience can meet the needs of different learners, stimulate their learning interest, and further enhance learning outcomes.

6.2 Facing Challenges and Coping Strategies

Despite the many advantages of the platform, it still faces some challenges in practical applications. Firstly, technological updates and iterations occur rapidly, and the platform needs to continuously keep up with the latest technological trends to maintain its leading position. To this end, we will increase research and development investment and establish a professional technical team responsible for the continuous upgrading and optimization of the platform. At the same time, we will actively collaborate with universities, research institutions, etc., to introduce advanced technologies and ideas to jointly promote the innovative development of the platform. Secondly, data security and privacy protection are issues that cannot be ignored during the operation of the platform. We will establish a comprehensive data security management system and strengthen data encryption and backup measures to ensure the security and privacy of user data.

7. Conclusion

In summary, the integration of big data and artificial intelligence in college physics teaching has demonstrated remarkable results, significantly enhancing teaching efficiency and quality while providing students with a more personalized and intelligent learning experience. By deeply analyzing learning data, teachers can accurately grasp students' learning progress and needs, thereby formulating more targeted teaching strategies. Additionally, intelligent teaching aids have effectively reduced teachers' workload, allowing them to focus more on improving teaching quality. Looking ahead, deepening the integrated application of big data and artificial intelligence in teaching will be a continuous direction of effort. It is necessary to continuously explore more diversified teaching methods and means to meet students' diverse learning needs. Furthermore, strengthening interdisciplinary cooperation and resource sharing to promote educational innovation is also an important way to improve teaching quality. It is believed that in the near future, big data and artificial intelligence will play an even more crucial role in the field of education, contributing more to the cultivation of high-quality talent.

References

[1] Hou Junfang. Research on Secondary Vocational Physics Teaching and Evaluation in the Era of Big Data and Artificial Intelligence [C]// Beijing International Exchange Association. Proceedings of the 5th Education Innovation and Experience Exchange Seminar 2024. Baoji Fengxiang Vocational Education Center; 2024: 74-77.

[2] Wang Weidong. The Application of "Artificial Intelligence + Big Data" in Junior High School Physics Teaching [J]. Enlightenment and Wisdom (Upper), 2024, (10): 42-44.

[3] Qi Fazhi, Li Gang, Li Chun, et al. Big Data Technologies and Applications in High-Energy Physics Based on Artificial Intelligence [J]. Frontiers of Data and Computing, 2023, 5(02): 50-59.

[4] Deng Lijun, Huang Yupeng. Construction and Use of a Physics Error Question Bank Supported by Artificial Intelligence [J]. Middle School Physics, 2021, 39(18): 48-51.

[5] Li Qiao, Liu Lihua, Fei Jinyou. Exploration of the Application of Artificial Intelligence in Physics Teaching [J]. Xueyuan, 2020, 13(36): 47-48.