

Research on Precise Teaching Strategies for College English Based on Artificial Intelligence Technology and Big Data Analysis

Zhihua Han*

JiNing Normal University, Ulanqab, 012000, China

*Corresponding author: hanzhihua_2007@163.com

Abstract: *With the deep development of information technology, artificial intelligence and big data analysis provide new possibilities for resolving the contradiction between standardized education and personalized cultivation in college English teaching. Based on learning theories, data science, and the logic of technology enablement, this study systematically constructs an application model encompassing the generation of personalized learning paths, dynamic regulation of the teaching process, and intelligent integration of resource evaluation. Furthermore, it proposes a precision teaching strategy system centered on a multidimensional design framework, key operational procedures, and a continuous optimization mechanism. The research demonstrates that through the deep integration of data-driven approaches and intelligent algorithms, a paradigm shift from standardized teaching to precise intervention can be achieved, effectively enhancing both teaching efficiency and learning experience. This study provides systematic theoretical support and practical pathways for the reform of college English teaching.*

Keywords: *artificial intelligence; big data analysis; college English; precision teaching; learning analytics; personalized learning*

Introduction

In the context of college English teaching facing significant differences in students' foundational knowledge, diversified learning needs, and insufficient adaptability of traditional teaching models, exploring how to effectively utilize intelligent technologies to enhance teaching precision has become an important topic. This study is grounded in the educational application potential of artificial intelligence and big data technologies, and aims to systematically construct a theoretical framework and practical strategies for precision teaching in college English. The necessity of this research lies in breaking through experience-dominated teaching conventions, and through data-driven precise diagnosis and intelligent intervention, achieving optimal allocation of teaching resources and effective regulation of the learning process; this not only holds practical significance for improving college students' comprehensive English application abilities but also represents a theoretical exploration into promoting the deep integration of information technology and foreign language education and building a new smart teaching ecosystem.

1. Theoretical Foundation of Artificial Intelligence and Big Data Technology Empowering College English Teaching

1.1 Integration Mechanism of Learning Theories and Intelligent Technologies

The modern development of learning theories provides directional guidance and rational explanations for the educational application of intelligent technologies. Behaviorist learning theory emphasizes the formation of connections between external stimuli and responses, and its ideas are reflected in adaptive learning systems, where the systems shape students' language behaviors through immediate feedback and reinforcement exercises. Cognitivist theory focuses on the internal processes of information processing, and artificial intelligence technology, by modeling students' cognitive load and knowledge structures, can optimize the sequence and methods of information presentation, promoting the effective transformation of working memory into long-term memory. A more profound influence comes from constructivist and sociocultural theories, which emphasize learners' active

meaning construction and social interactions in specific contexts. Intelligent technologies provide rich activity carriers and mediating tools for social construction by creating virtually authentic language application scenarios, offering intelligent learning companions, and supporting cross-spatiotemporal collaborative learning. The essence of this integration mechanism is that the learning laws revealed by learning theories are algorithmized, modeled, and embedded into the design and operation of teaching systems, enabling technological interventions to align with the intrinsic mechanisms of human learning.

1.2 Core Theoretical Support for Data-Driven Teaching

The establishment of the data-driven teaching paradigm is supported by core theories stemming from the integration of data science, learning analytics, and educational measurement. Data science provides the fundamental methodology for extracting value from massive, multimodal educational data, including a series of technical processes such as data collection, cleaning, mining, and visualization. Learning analytics, as a discipline dedicated to studying data about students and their learning environments, constitutes a bridge connecting raw data with teaching decisions. By modeling and analyzing learners' behavioral data, process data, and outcome data, it aims to understand and optimize the learning process and the context in which it occurs^[1]. Modern assessment theories in educational measurement, such as Item Response Theory and cognitive diagnostic theory, provide precise tools for in-depth interpretation of students' micro-level ability structures. These theories make it possible to move beyond traditional total score evaluations and achieve fine-grained diagnosis of the mastery of language knowledge points, cognitive skill levels, and even tendencies in learning strategy usage. Together, these three fields form a complete theoretical chain from data acquisition to cognitive insight, ensuring that teaching decisions are not based on experiential intuition but are grounded in the scientific interpretation of objective data.

1.3 The Internal Logic of Technology Enablement in Language Teaching

The internal logic of technology enablement in language teaching manifests itself through an evolution from instrumental assistance to structural reshaping. Its primary form functions as an efficiency tool, where technologies such as machine translation and speech recognition replace certain mechanical tasks in traditional instruction. A deeper dimension of this enablement logic lies in its cognitive and social empowerment capabilities. Cognitive enablement refers to technology serving as an extension of cognitive organs, expanding learners' thinking and learning capacities. For instance, big data analytics can reveal knowledge gaps and cognitive pathways that learners find difficult to self-identify, while artificial intelligence can act as an infinitely patient tutor providing personalized cognitive scaffolding. Social enablement is reflected in technology's role in creating and mediating language communication contexts, breaking through the physical constraints of classrooms and enabling learners to connect with global communities of language practice. Ultimately, the highest form of technology enablement is ecological restructuring, where artificial intelligence and big data technologies no longer remain external to the teaching system but deeply integrate with curricular elements, pedagogical methods, and assessment mechanisms, giving rise to a new smart teaching ecosystem capable of self-evolution and dynamic adaptation. This internal logic indicates that the ultimate direction of technological application is to achieve holistic optimization and paradigm transformation of the teaching system.

2. Application Models of Artificial Intelligence and Big Data Technology in College English Teaching

2.1 Intelligent Generation Model of Personalized Learning Paths

The intelligent generation model of personalized learning paths operates based on the continuous and multi-dimensional collection and analysis of learner data. This process begins with an accurate diagnosis of the learner's initial state, where the system conducts baseline measurements of students' vocabulary size, grammatical complexity, reading fluency, and listening-speaking abilities using adaptive testing tools. As the learning process advances, the Learning Management System and interactive applications continuously record students' micro-behavioral data, such as time spent on specific knowledge points, patterns of attempt frequency and accuracy rates in exercises, as well as fluency and accuracy metrics in human-computer dialogues^[2]. These behavioral data and cognitive assessment data corroborate each other, collectively constructing a dynamically evolving and

continuously refined digital profile of the learner.

Based on this profile, intelligent algorithms begin to play their core role. Machine learning models, particularly collaborative filtering and knowledge graph-based recommendation algorithms, conduct in-depth mining of the structured learning resource repository. The system not only matches resources based on surface-level tags but also comprehends their inherent knowledge correlations and cognitive difficulty levels. When a learner demonstrates persistent difficulties in exercises related to the subjunctive mood, the system not only recommends explanatory videos on the subjunctive mood but may also retrospectively push prerequisite knowledge—such as review materials on relevant tenses and clauses—thereby forming a remedial learning sequence with logical progression.

The generation of this path is not a one-time process but rather a dynamic closed loop with self-optimization capabilities. The system monitors students' interactive feedback on recommended resources to evaluate the effectiveness of the path in real time. If students show improvement in subsequent formative assessments, the current path's rationality is validated; if the results are unsatisfactory, the algorithm recalculates and adjusts the resource sequence and teaching strategies. This continuous data feedback and model iteration ensure that the learning path remains synchronized with the learner's latest cognitive state, truly realizing the transition of "teaching students according to their aptitude" from concept to operational practice.

2.2 Data-Driven Dynamic Regulation Model of the Teaching Process

The data-driven dynamic regulation model of the teaching process aims to transform classroom instruction from an art highly dependent on teachers' personal experience into a scientific decision-making activity based on real-time data insights. This model constructs an agile closed loop of "perception-analysis-intervention," significantly enhancing the timeliness and precision of teaching responses. Its data perception layer is widely distributed throughout the teaching environment, including task completion trajectories recorded by online learning platforms, question-and-response data captured by classroom interaction systems, and even students' emotional states of classroom participation analyzed through speech emotion recognition technology. These multi-source heterogeneous data streams collectively form a digital mirror of the classroom teaching ecology.

The learning analytics engine, serving as the brain of this model, is responsible for rapidly processing and deeply mining these massive, high-dimensional real-time data. Through data visualization dashboards, teachers gain insights that were previously difficult to achieve. For example, the system can instantly mark the distribution of options for a reading comprehension question across the entire class, quickly identifying common misconceptions; it can also automatically extract hotspots and blind spots in discussions through textual analysis of group discussion recordings, providing factual basis for teachers' intervention and guidance. This comprehensive overview, from macro group trends to micro individual anomalies, enables teachers to transcend subjective experience and make objective teaching diagnoses^[3].

On this basis, dynamic regulation can be implemented. Teachers can flexibly adjust pre-set teaching progress based on data alerts, provide centralized explanations for exposed common issues, or temporarily initiate a group debate to deepen understanding of controversial topics. For individual students, teachers can receive system alerts about declines in learning engagement or specific difficulties, thereby providing timely personalized attention and guidance. This model fundamentally transforms the fixed linear progression of traditional classrooms, turning them into vibrant organisms capable of intelligent adaptation based on real-time learning feedback, achieving a dynamic balance between teaching progression and learning needs.

2.3 Intelligent Integration Model of Teaching Resources and Assessment

The intelligent integration model of teaching resources and assessment aims to address the structural challenges of disconnection among resources, instruction, and evaluation in traditional teaching. This model closely couples these three elements through data bridges and intelligent algorithms, forming a self-optimizing, cyclically reinforcing teaching ecosystem. Its primary step involves achieving deep intelligentization of teaching resources. Technologies such as natural language processing are employed to automatically perform semantic annotation, content summarization, and key information extraction from unstructured resources like texts, audios, and videos. These resources are then categorized and correlated according to a unified knowledge system, thereby constructing a dynamic knowledge graph that is machine-readable, comprehensible, and capable of inference.

The assessment component is redefined as a continuous data collection point. Its form evolves from isolated summative examinations to embedded formative evaluations permeating the entire learning process. Every draft revision a student makes on an intelligent writing platform, every dialogue recording in a speaking practice application, and every click selection in interactive exercises are captured by the system and transformed into analyzable evaluation data. Based on these process-oriented data, the function of assessment shifts from mere grading to in-depth diagnosis of students' learning states and cognitive processes.

The intelligent integration of resources and assessment is precisely achieved based on this diagnostic foundation. When the system identifies through automated essay evaluation that a student has the problem of "using connectives in a monotonous way," it immediately locates and pushes micro-lecture videos and example libraries about "detailed explanations of English logical connectives" from the resource knowledge graph. Similarly, if big data analysis reveals that students across multiple classes generally perform poorly on the knowledge point of "citation norms in academic English writing," the system can not only automatically push remedial learning packages to the relevant groups but also generate teaching alerts and resource suggestions for instructors, prompting them to strengthen this component in subsequent teaching. This mechanism, where "assessment serves as a resource recommendation trigger," ensures highly targeted teaching support, transforming every assessment activity directly into a driving force for optimizing subsequent learning experiences. Ultimately, this constructs a smart teaching environment centered on data, capable of autonomously adapting to changes in learning conditions.

3. Construction and Implementation Pathways of Precision Teaching Strategies for College English

3.1 Multidimensional Design Framework for Precision Teaching Strategies

The design of precision teaching strategies is not a single-dimensional adjustment but rather a comprehensive system architecture encompassing objectives, content, intervention, and evaluation. The cornerstone of this framework is the aligned mapping of teaching objectives and data indicators. At the macro level, the overall objectives of the curriculum standards are broken down into a series of observable and measurable micro-competency units, such as the ability to apply vocabulary in specific contexts, and the ability to comprehend and produce complex sentence structures^[4]. These micro-competency units form the target matrix for precision teaching. In the content dimension, it is necessary to establish a corresponding integrated network of "knowledge-resource-activity." Semantic network technology is utilized to deconstruct and tag textbooks and extended resources, enabling precise associations with competency points in the target matrix and ensuring that any teaching intervention directly targets specific competency development.

In the intervention dimension, the design framework must pre-establish a diverse library of teaching response strategies. This includes group-based reconstruction teaching strategies targeting common weaknesses, such as specialized training modules that can be automatically invoked when data indicates most students struggle with a particular listening skill. It also includes personalized support strategies addressing individual differences, such as gamified task sequences designed for learners with low motivation, or extended academic English literature reading packages for advanced learners. The evaluation dimension permeates the entire process, and its design must transcend traditional summative functions by strengthening the weight of process data collection and analysis, deeply embedding evaluation into the learning workflow to form a tight closed loop of "teaching-evaluation-reteaching." This multidimensional framework collectively ensures that the design of teaching strategies is both systematic and flexible, providing a clear blueprint for precise implementation.

3.2 Key Operational Procedures for Strategy Implementation

The implementation of strategies requires a clear and orderly operational process to ensure that precision teaching transitions from concept to stable teaching practice. This process begins with dynamic diagnosis of learning conditions. At this stage, the system comprehensively generates diagnostic reports on individual and group learning conditions through pre-assessment, analysis of learning behavior data, and potential affective computing technologies. This report must clearly identify knowledge gaps, competency deficiencies, and learning characteristic tendencies, providing a factual basis for subsequent decision-making.

The process then enters the teaching decision and path generation phase. Teachers and the system form a human-machine collaborative decision-making community at this stage. Based on the diagnostic report, the system intelligently recommends optimal intervention plan combinations from the pre-established teaching strategy repository, for example, suggesting the initiation of collaborative inquiry tasks for Group A and pushing adaptive practice sequences for Student B. Teachers, combining their professional judgment, review, fine-tune, and confirm the system's recommendations, ultimately forming a formal execution plan. The key to this phase lies in the complementary advantages of human and machine, where the system provides data insights and scalable solutions, and teachers contribute educational wisdom and contextual understanding^[5].

Finally, the phase of precise intervention execution and concomitant data collection begins. The approved teaching strategies are seamlessly deployed to students' learning terminals, presented in a perceivable manner, such as personalized to-do task lists and recommended learning resources. Throughout the execution process, the system continuously collects students' interaction data, including task completion quality, resource browsing depth, and participation levels in discussion forums, feeding these process data back to the analytics engine in real time. This procedure forms a complete "diagnosis-decision-execution" closed loop, where the output of each cycle provides input for the initiation of the next, rendering the teaching implementation a highly data-driven continuous process.

3.3 Continuous Optimization Mechanism for Teaching Effectiveness

The key to ensuring the self-evolution capability of the precision teaching system lies in establishing a continuous optimization mechanism for teaching effectiveness. The core of this mechanism is constructing a multi-level data feedback and analysis loop. At the most immediate micro-level, effectiveness evaluation of intervention strategies based on A/B testing is continuously conducted. The system can conduct controlled small-scale comparative experiments on different teaching strategies for the same learning objective, such as two different vocabulary memory games. By analyzing the performance differences of students under identical evaluation metrics, more effective teaching methods are screened, thereby continuously optimizing the components of the strategy repository.

At the meso-level, a mechanism for reviewing teaching closed loops and iterating models is established. Regular retrospective analysis of the complete "diagnosis-decision-execution" closed loop is conducted to verify whether the causal chain from diagnosis to intervention holds. For instance, examining whether the interventions implemented for "weak inferential reading comprehension skills" resulted in the expected competency improvement in subsequent assessments. This review process not only validates the effectiveness of teaching strategies but is also utilized to optimize the algorithmic models driving the entire system. Through training on large volumes of historical data, learning analytics models can enhance their diagnostic accuracy and recommendation precision, thereby achieving iterative upgrades^[6].

At the macro-level, it is essential to conduct long-term learning trajectory tracking and attribution analysis. By conducting longitudinal studies on students' learning data spanning multiple semesters or even longer periods, researchers can analyze critical junctures in competency development and influencing factors, while exploring the profound effects of different precision teaching strategies on long-term learning outcomes. These macro-level insights, in turn, can guide adjustments in micro-level strategies and optimize meso-level models, forming a comprehensive, sustainable optimization ecosystem that progresses from short-term feedback to long-term planning, and from micro-level adjustments to macro-level strategies. This ultimately drives the precision teaching system toward continuous improvement through dynamic development.

Conclusion

This study systematically constructs a precision teaching strategy system for college English based on artificial intelligence and big data analysis, providing an in-depth exploration from theoretical foundations and application models to implementation pathways. This paper demonstrates that teaching strategies centered on data-driven approaches and intelligent technologies can effectively promote the transformation of college English teaching toward precision, personalization, and intelligentization. Future research and practice should further focus on new pathways for teacher roles and professional development empowered by intelligent technologies, explore the optimal balance in human-machine collaborative teaching decision-making, and commit to building more open and interoperable smart

teaching platform architectures. Meanwhile, with the advancement of multimodal data collection and analysis, it is necessary to strike a balance between technological application and data ethics, ensuring that precision teaching enhances quality while adhering to sound educational principles and value orientations, thereby promoting the sustainable development and ecological restructuring of college English teaching in the intelligent era.

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