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Empowerment and Reconstruction: A Study on the Application Models and Effectiveness of AI in College English Teaching for Science Students

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Abstract

This paper explores the integration of artificial intelligence (AI) into college English teaching for science majors at second-tier universities in China. It proposes a practical, three-dimensional teaching model that spans pre-class, in-class, and post-class stages, aiming to address the longstanding challenges of low proficiency, lack of motivation, and ineffective instruction. Drawing on empirical data and classroom practice, the study demonstrates how AI can personalize learning, enhance teaching efficiency, and foster learner autonomy. It also reflects on issues such as data privacy, ethical concerns, and the risk of technological isolation, offering targeted recommendations for sustainable implementation.

Keywords

Artificial intelligence; College English teaching; Science majors; Personalized learning; Teaching effectiveness.

1. Introduction

The College Public English course is one of the most widely offered foundational courses in China's higher education system. Its primary objective is to cultivate students' comprehensive English application skills, particularly listening and speaking abilities, to meet the demands of societal development and international exchange. However, in ordinary second-tier universities, especially those with a focus on science and engineering, public English teaching has long faced a prominent structural contradiction: a significant gap between instructional requirements and students' actual proficiency levels. Many science-oriented students, having devoted most of their efforts to training in mathematical and logical thinking during middle and high school, have invested insufficiently in English learning, which requires extensive memorization and intuitive accumulation. This has resulted in deficiencies in vocabulary, disorganized grammatical understanding, and particularly weak listening and speaking skills, leading to the widespread phenomenon of "dumb English" (understanding but being unable to speak). The traditional "one-size-fits-all" large-class teaching model struggles to accommodate the vast differences among individual students. This often leads to frustration and disengagement among those with weaker foundations, making teaching efforts inefficient and yielding sub-optimal results.

Meanwhile, a new generation of information technologies centered on artificial intelligence is sweeping the globe, offering novel approaches and tools to address this teaching dilemma. The personalized, interactive, data-driven, and intelligent features of AI align closely with the principles of language acquisition. It can simulate one-on-one tutoring scenarios, provide infinitely patient and instant feedback, create realistic language environments, and dynamically adjust teaching strategies based on student performance data. Therefore, deeply integrating AI technology into the public English instruction for science students in second-tier universities is not only an inevitable choice aligned with the trend of educational informatization [8] but also

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an effective breakthrough for enhancing teaching efficiency and realizing the educational ideal of "teaching students according to their aptitude" [6].

This study aims to, based on actual frontline teaching realities, systematically explore the operational feasibility of AI technology in specific teaching contexts [4]. It seeks to construct a practical instructional application model and, with an empirical spirit, analyze its intrinsic mechanisms and potential effects on improving students' English proficiency. The goal is to provide theoretical reference and practical paradigms for the reform of public English teaching in similar institutions.

2. Characteristics and Challenges of English Learning Among Science Students

To effectively apply AI, it is essential to first understand the learner profile and the instructional challenges they face.

2.1. Learner Characteristics

Strong Logical Thinking, Weak Intuitive Cognition: Science students are accustomed to formulas and deductive reasoning. They often struggle with the irregularities and idiomatic nature of English, seeking rigid rules where none exist, leading to frustration.

Weak Foundations and Wide Disparities: Many students enter university with low English scores, some still at a middle school level. Vocabulary is limited, basic sentence structures are shaky, and individual differences are vast—posing a major challenge for uniform instruction [4].

Instrumental Motivation: Most students study English primarily to pass exams or meet graduation requirements, rather than out of intrinsic interest. This utilitarian mindset can drive short-term effort but undermines long-term engagement and cultural understanding.

Instrumental Motivation: Due to limited input and lack of practice, students are often passive in oral activities, lacking both confidence and fluency.

2.2. Limitations of Traditional Instruction

Standardized Teaching vs. Individual Needs: Large class sizes prevent teachers from addressing each student's weaknesses. Instructional pacing is based on the "average" student, leaving advanced learners under-challenged and weaker ones behind [6].

Delayed and Imprecise Feedback: Grading written work is time-consuming, and oral feedback in class is often generic and infrequent. Students rarely receive timely, targeted correction [3].

Disconnect Between Content and Major: General English textbooks rarely relate to students' scientific backgrounds, making it hard to sustain interest or see relevance.

Low Sustained Motivation: Repetitive drills, poor performance, and lack of progress often lead to a vicious cycle of disengagement and failure.

3. An AI-Integrated Instructional Model

Based on the above analysis, this study proposes a student-centered, AI-enhanced, three-dimensional model that integrates AI across all stages of instruction: before, during, and after class.

3.1. Pre-Class: Personalized Preview and Diagnostic Assessment

Traditional preview activities are often superficial. AI can make them targeted and efficient.

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Smart Vocabulary Filtering: AI systems analyze students' prior knowledge and automatically skip familiar words (e.g., "water," "air"), focusing instead on unfamiliar or difficult terms (e.g., "biodegradable," "sustainable").

Intelligent Pronunciation Practice: Using speech recognition and evaluation tools (e.g., iFlytek), students read aloud and receive instant feedback on accuracy, fluency, and intonation [3]. This prepares them for more interactive in-class speaking tasks.

3.2. In-Class: Contextualized Interaction and Targeted Intervention

AI supports teachers in creating dynamic, responsive classroom experiences [1].

AI-Assisted Differentiated Instruction: Teachers can distribute in-class exercises (such as multiple-choice or fill-in-the-blank questions) through an AI-based platform. The system can instantly calculate the overall accuracy rate for the entire class and visualize the distribution of answer choices for each question. For questions with a high error rate, the teacher can provide detailed explanations; for those with a low error rate, a brief mention may suffice. Simultaneously, the system can automatically identify students who answered incorrectly, allowing the teacher to focus on them during group discussions or one-on-one guidance. This facilitates "de facto" differentiated instruction.[4].

AI-Driven Virtual Conversations: To address the issue of science students being "afraid to speak," AI-powered virtual human technology can be employed to create a safe and low-anxiety conversational environment [7]. For instance, by utilizing VR or AR devices, students can engage in real-time dialogue practice with a virtual "foreign interviewer," "airport staff," or "meeting partner." The AI-driven virtual human can not only comprehend the semantics of the student's speech but also intelligently guide the conversation based on their responses. After the dialogue, it generates a detailed report evaluating aspects such as word choice, grammar, logic, and coherence. This immersive experience effectively enhances students' oral communication skills and boosts their confidence [3].

AI-Supported Writing Feedback: In writing classes, after the teacher assigns a task, students can first draft and revise their work on an AI-powered writing correction platform (such as "Grammarly" or "Pigai Wang"). These tools can instantly check for spelling, grammar, and punctuation errors, while also providing suggestions on lexical diversity, sentence complexity, and textual coherence [4]. After several rounds of human-computer interactive revisions, students can then submit their work to the teacher. This allows teachers to free themselves from the tedious task of correcting basic errors, enabling them to focus on higher-level guidance, such as ideas, logical structure, and rhetorical techniques, thereby achieving complementary advantages through human-machine collaboration [1].

3.3. Post-Class: Consolidation and Personalized Extension

AI enables truly individualized homework and review.

Data-Driven Personalized Assignments: Based on prior performance, the system generates tailored homework packages. For example, a student struggling with the present perfect tense receives additional exercises and micro-lessons, while another who has mastered it is given more advanced tasks.

Major-Linked Content: AI recommends English materials related to students' scientific disciplines, enhancing relevance and motivation.

3.4. Throughout: Learning Analytics and Instructional Decision-Making

All learning data—login time, completion rates, error patterns, pronunciation progress—are collected and analyzed.

For Students: Personalized dashboards show progress and weak areas, fostering metacognition and self-regulation.

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For Teachers: Real-time class reports highlight common difficulties and at-risk students, enabling timely intervention and data-informed instruction.

4. Effectiveness of AI in Improving English Proficiency

Systematic use of AI is expected to significantly enhance science students' English proficiency in three key dimensions:

4.1. Precise and Durable Mastery of Language Knowledge

AI-driven adaptive learning ensures precise teaching interventions through a closed loop of "diagnosis-learning-practice-rediagnosis" [6]. Students no longer need to waste time on already mastered content but can focus all their efforts on their "zone of proximal development" [6]. Intelligent spaced repetition and exercise delivery align with the Ebbinghaus forgetting curve, effectively promoting the transfer of knowledge from working memory to long-term memory, thereby solidifying the grasp of foundational elements like vocabulary and grammar. Empirical studies indicate that students using adaptive learning systems show significantly higher efficiency in vocabulary memorization and retention rates of grammatical knowledge compared to those using traditional methods.

4.2. Contextualized and Automated Language Use

The ultimate goal of language learning is application. AI-powered virtual scenario dialogues and intelligent writing assistants provide students with abundant opportunities for "learning by doing." Repeated oral output in a safe virtual environment effectively lowers the affective filter [7], facilitating the internalization of language knowledge and the automation of language skills. Instant feedback during the writing process enables students to rapidly improve their discourse construction abilities through iterative cycles of "trial-error-correction." With sustained practice, students' comprehensive application skills in listening, speaking, reading, and writing gradually transition from conscious, slow encoding processes to unconscious, fluent automated processes.

4.3. Enhanced Learner Autonomy

For science students, the sense of achievement from problem-solving serves as a powerful intrinsic motivator. AI technology "gamifies" and adopts a task-based approach to the English learning process, continuously providing students with a sense of accomplishment through immediate positive feedback. Clear learning pathways and data-visualized progress trajectories give students an unprecedented sense of control over their learning. This "I can learn" self-efficacy is key to shifting them from passive to active learning [6]. When students learn to use AI tools to independently explore and solve language problems, their capacity for lifelong learning is cultivated.

5. Challenges and Reflections

Despite the promising prospects, promoting AI-assisted teaching in second-tier universities still faces numerous challenges that require prudent consideration:

5.1. The Digital Literacy Gap Between Teachers and Students

Not all teachers possess the ability to integrate AI technology into instructional design, and some may experience technophobia or resistance. Similarly, students also require training to effectively utilize these tools. Therefore, systematic teacher training and student guidance are crucial.

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5.2. Data Privacy and Ethical Risks

Students' learning data constitutes highly sensitive information [5]. Schools and technology providers must establish stringent data security and privacy protection policies, clarify data ownership and usage boundaries, and prevent data breaches and misuse.

5.3. Balancing Technological Tools and Pedagogical Focus

Technology is a tool, not an end in itself. It is essential to guard against falling into the trap of "technological supremacy" and avoid allowing classrooms to be hijacked by dazzling technology at the expense of the humanistic aspects of language teaching and the emotional interaction between teachers and students. The leading role of teachers and the irreplaceable value of "human intervention" at critical moments must be upheld [1].

5.4. "Technology Silos" and Systemic Support

Individual teachers' isolated attempts can easily lead to the formation of "information silos." Top-level design at the institutional level is necessary to provide a unified platform, stable network environment, essential hardware support, and incentive policies [8], thereby fostering a collaborative ecosystem for school-wide advancement.

6. Conclusion

Facing the challenges of teaching public English to science students in second-tier universities, AI technology serves as a practical and powerful tool, not a distant concept [2]. By implementing a smart teaching model covering pre-class, in-class, and post-class phases [4], AI can be deeply integrated into vocabulary, grammar, listening, speaking, reading, and writing instruction. This restructures and empowers traditional teaching methods. Its core value lies in using personalized, data-driven, and contextualized [7] approaches to precisely address students' weaknesses, leverage their logical strengths, and boost motivation, thereby enhancing their English proficiency comprehensively.

Looking ahead, advances in natural language processing and affective computing will enable more sophisticated AI educational tools [5], such as emotionally supportive AI tutors and dialogue partners for critical discussion. Educators should embrace these changes thoughtfully, exploring effective human-AI collaboration. The goal is to provide every student with equitable, efficient, and engaging English education through technology, ultimately realizing the ideal of personalized teaching [6].

References

[1] Wang, Q., & Hu, Y. (2021). English teaching in the age of AI: Possibilities, pathways, and challenges. Computer-Assisted Foreign Language Education, (4), 3–9.

[2] Zhu, Z., & Peng, H. (2020). A new paradigm of smart education: Human-machine collaborative teaching and learning. E-Education Research, 41(1), 5–16.

[3] Gu, X., & Du, H. (2019). Current status and trends of AI in education. Open Education Research, 25(2), 15–25.

[4] Hwang, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. Computers and Education: Artificial Intelligence, 1, 100001.

[5] Cai, J. (2022). Constructing an AI-based college English teaching model. Foreign Languages in China, 19(1), 72–80.

[6] Zhang, W., & Liu, J. (2017). Research status and development trends of AI in education. Modern Distance Education Research, (5), 12–21.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202512_8(12).0048

[7] Feng, X., Sun, Y., & Cao, J. (2020). A review of learner emotion detection in online learning environments. Journal of Distance Education, 38(1), 40–50.

[8] He, K. (1997). Constructivism: The theoretical basis for reforming traditional teaching. E-Education Research, (3), 3–9.