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College English Vocabulary Teaching Empowered by AI

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Abstract

Vocabulary is an indispensable part of the language system and the keystone of linguistic competence. Therefore, vocabulary teaching has always been a key issue in the reform of college English instruction. By reviewing domestic research on vocabulary teaching, this paper traces the evolution from traditional methods, corpora, and multimedia to AI-assisted vocabulary teaching, and points out that generative artificial intelligence (AI) offers new possibilities for resolving the long-standing problems of "isolation, mechanicalness, and fragmentation, monotony" in traditional vocabulary learning and teaching. It proposes and elaborates a three-dimensional teaching model—Multimodal Perception, Deep Construction, and Situated Transfer—a human–machine collaborative teaching model empowered by AI, and discusses the model in terms of its design, implementation process, evaluation mechanism, and experimental outcomes. The results indicate that this three-dimensional model, integrating human–machine interaction, process management, timely feedback, and targeted correction, can significantly enhance students' vocabulary competence and eventually boost their reading, writing, and overall language proficiency. Human–machine collaborative teaching assisted by generative AI represents an important direction for the future of college English vocabulary teaching.

I. INTRODUCTION

Vocabulary, as the cornerstone of English competence, is the starting point of all language acquisition and, sometimes, the nightmare of many English learners. Without vocabulary, all the other language skills—listening, speaking, reading, writing, and translating—would remain out of reach. Vocabulary determines the breadth and depth of language expression, enabling learners to convey their thoughts properly and to probe further into more advanced skills in related fields. Nevertheless, in college English vocabulary teaching and learning, compared with the

high input of time and energy, learning outcomes have always been far from satisfactory. Many students complain that they can recognize words in reading but cannot use them in specific contexts or in their writing. Generative artificial intelligence, as a representative of emerging technologies, presents an unprecedented opportunity for reform in college English vocabulary teaching.

1.1 The Status of Vocabulary in College English

Vocabulary is one of the three major elements of language (phonology, vocabulary, and grammar) and the pillar on which the language system is based. As J. Harmer (1991) states: "If language structures make up the skeleton of language, then it is vocabulary that provides the vital organs and the flesh." The renowned British linguist D. A. Wilkins also made such a penetrating remark: "Without grammar very little can be conveyed; without vocabulary nothing can be conveyed" (Wilkins, 1972). Thus, it is obvious that vocabulary, as the bedrock of language, is a crucial component of English teaching, running through the whole English learning process. Learners' vocabulary size directly determines the accuracy of their reading comprehension and written expression.

Since the establishment of college English courses, vocabulary teaching has always been a focus of attention for English teachers. According to *The College English Syllabus* issued in 1985 (Revision Working Group, 1985) and its subsequent revised editions, non-English majors should master approximately 4,000 words by the end of the basic stage, while at the intermediate and advanced stages, that figure climbs to 6,000. With the advent of the CET-4/CET-6 examinations and multiple revisions of the *Guidelines on College English Teaching* (Ministry of Education Steering Committee for College Foreign Language Teaching, 2020), English vocabulary still occupies a fundamental and overarching position and remains a key indicator of college English teaching.

1.2 Problems in College English Vocabulary Teaching and Learning

Although the importance of vocabulary is widely recognized, numerous problems still confront college English vocabulary teaching. On the one hand, students find that vocabulary learning merely means memorizing isolated words mechanically, which leads to low memorization efficiency and rapid forgetting. Besides, this memorization is fragmented in that words are stored in students' memory as unrelated symbols, having little systematic relationship with other knowledge in their existing knowledge network. Furthermore, the gap between understanding and application remains wide. Students can recognize isolated words but have great difficulty using them in appropriate contexts or real communication. Lastly, they lack effective strategies for vocabulary learning, resulting in a gradual loss of learning interest.

On the other hand, teachers tend to adopt monotonous methods to present vocabulary, centering on repetitive explanation and daily dictation, and lacking effective individualized approaches when tackling students of different levels and characteristics. The feedback they receive is delayed, so teachers cannot identify students' deficiencies in time and make prompt adjustments. These problems are intertwined, jointly constraining the effectiveness of vocabulary teaching and posing an urgent demand for innovation in teaching models and methods.

II. LITERATURE REVIEW

2.1 Research on Vocabulary Teaching in Chinese College English

In Chinese college English education, research on vocabulary teaching has roughly undergone an

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evolution through three stages: method exploration, theoretical guidance, and technological empowerment.

The period from the late 1980s to the early 1990s witnesses the emergence of sporadic research on vocabulary teaching in its earliest form. Research in this period centers on specific methods such as word pronunciation, word formation, synonym association, antonym contrast, or learning through reading, yet underestimates the role of context in vocabulary comprehension and application (Xie, 1990). At the same time, the objectives and methods of college English teaching are gradually clarified through constant discussion (Wang, 1996). These early efforts are mainly experience-based, with little theoretical guidance. Nonetheless, they lay a solid foundation for subsequent, more systematic research. Thereafter, with the introduction of more linguistic theories into the field of language teaching, an increasing number of studies on vocabulary teaching are designed under the guidance of linguistic theories such as semantics, pragmatics, and stylistics.

By around 2000, with more emphasis on cognition and cultural communication, theories of cognitive psychology, cognitive linguistics, and cross-cultural communication have started to inform research on college vocabulary teaching and learning, and this trend has always been a significant aspect of research in English education. Based on the domestic and international research findings in cognitive psychology at that time, Wu (1996), by utilizing the implications of the cognitive findings on memory, concerning episodic memory, associative memory, and imagery memory, examines the presentation frequency of vocabulary and rules of forgetting, proposing the possibility of combining the two. Guan (1997), based on the discussions of the relationship between semantics, pragmatics and vocabulary teaching, confirms the positive role played by the theories in English vocabulary instruction. Zhou and Wen (2000) track changes in students' vocabulary size in one class over a four-year longitudinal study, and by using the findings of the study, they investigate the impact of vocabulary growth on students' language proficiency. Lu (2001), gaining inspirations from context theory, discusses the developmental trends in vocabulary teaching and testing. Chen (2002), drawing on the cognitive psychological theory of meaningful learning, demonstrates the significant role of etymological knowledge in students' English vocabulary learning. Liang (2002) argues that, from the perspective of cognitive linguistics, several key concepts, including basic-level category vocabulary, the semantic motivation of words, the deep connections among polysemous meanings, and the metaphorical meanings of words, can offer guiding significance for current college English vocabulary teaching. Gu (2002), based on the understanding of core vocabulary, sense-group teaching, and analysis-synthesis methods, investigates the role of integrating cognitive linguistics with English teaching practice. Lv (2004) argues that, in English vocabulary teaching, the integration of vocabulary, grammar, and text teaching can facilitate the cultivation of students' lexical pragmatic competence. Drawing on elaboration theory, Zhang and Wei (2004) experimentally investigate the differences in vocabulary learning effects due to different presenting ways in college English classrooms, and maintain that students' sentence production with the target words, based on their own cognitive structures, can actually enhance long-term retention of these words. Zhang (2005) argues that the findings in cognitive psychology and applied linguistics, concerning metacognition, can offer insights into the strategies and training procedures and content in English vocabulary instruction. Wu (2005), through a

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comparison of thinking modes, origins, geographical environments, beliefs, value systems, customs and habits between English and Chinese nations, systematically analyzes the lexical composition and their different connotations of the two cultures, discussing the specific approaches for the teaching of English vocabulary.

In recent years, with the emergence and boom of computational linguistics and corpus linguistics, corpora, with their massive databases, have become a focus of researchers and teachers in the field of foreign language teaching. They can provide reliable and objective language data for vocabulary teaching, thus laying a solid and systematic foundation for it. Scholars and researchers are shifting their attention to the relationship between corpora and vocabulary teaching, as well as the feasibility of combining the two to strengthen teaching effectiveness. Zhen (2005), by comparing the lemma coverage of spoken English vocabulary, suggests that in spoken English teaching, common lemmas should be given sufficient attention. Liang (2005) examines the use of corpora from the perspective of vocabulary teaching strategies, and claims that the development of corpora broadens teachers' horizons in vocabulary teaching, and that using corpora can help teachers obtain timely feedback and enhance teaching effectiveness and quality.

Thereafter, with the emergence and widespread application of big-data platforms and the popularization of smart classrooms, college English vocabulary teaching has become increasingly connected with a growing number of studies combining the two. Along with the mainstream research guided by linguistics, language teaching, and cognitive psychology, numerous empirical studies are emerging concerning multimedia-aided vocabulary teaching and learning. Zhu (2006), from the perspectives of vocabulary size and quality, compares students' scores and concludes that many new words are overlooked despite the effectiveness of multimedia assistance in vocabulary teaching, so teachers should carefully select the words to be explained in class. Yu (2009), by means of the "data-driven" learning model in an experiment with sophomore English majors, concludes that vocabulary teaching assisted by big data and lexical-grammar theory can yield great effectiveness. Zhai (2010), through teaching experiments, demonstrates that vocabulary-memory software can improve students' learning efficiency, and can also provide teachers with tools to strengthen students' independent vocabulary learning ability in college English teaching. Wang and Wang (2013) select three words expressing "influence"—effect, impact, and influence—from the COCA corpus, and study their collocations, semantic prosody, and semantic preferences, in the hope of broadening students' vocabulary acquisition and exploring new approaches to college English vocabulary teaching and learning.

Since 2015, research on mobile technology, online platforms, and smart classrooms has gradually increased. Shi (2016), using empirical methods, probes into the relationship between electronic media and students in the online multimedia environment, the different presentation modes, and their consequent differences in teaching and learning effects, concluding that traditional classroom vocabulary teaching assisted by online multimedia—which constitutes a recurring cycle of learning activities including audio imitation, form memorization, content cognition, cultural learning, and social communicative application—is the most effective mode for college vocabulary teaching. Liu (2017), based on a literature review, summarizes the main characteristics of smart education from the

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perspectives of technology, resources, and teaching, suggesting the systematic, technological, and application elements of a smart college English learning environment. Zhu (2018), against the background of smart classrooms, investigates how to exploit advanced information technology to the fullest to optimize the course design of college English vocabulary teaching and enhance learning effectiveness. Meng and Ma (2019), on the basis of online corpora, construct a teaching model of English for Specific Purposes, arguing that this model can facilitate students' development of vocabulary cognition and acquisition and promote the development of their autonomous learning ability. Cheng (2022) attempts to combine online teaching platforms—including https://www.pigai.org, https://oral.fifedu.com/, and WeLearn—with offline teaching, aiming at effective interaction and communication before, during, and after class, to mobilize students' initiative in oral English classes and reinforce the learning outcomes of English vocabulary. Wang (2024) conducts an experiment on the MOOC-based model for college English vocabulary teaching, exploring the role played by teaching resources and teachers from the perspectives of teaching methods, models, and teaching-effect evaluation mechanisms, thereby broadening vocabulary teaching approaches. Zhou (2024), through experimental methods and questionnaires assisted by ChatGPT, collects and analyzes students' learning outcomes, learning attitudes, and learning experiences, arguing that ChatGPT, the AI chatbot built on large language models, plays a significant role in improving students' vocabulary learning, though efforts are still needed to integrate it with traditional teaching approaches. Tong (2026) constructs a generative-AI-supported teaching model in the process of college English vocabulary teaching, following the order of context generation, intelligent integration, and data-driven improvement, attempting to improve teaching efficiency and learning outcomes and offering insights into college English vocabulary teaching. Gao and Gao (2026) claim that artificial intelligence can cultivate autonomous learning ability by pushing strategic task packages, thereby meeting individualized learning needs through adaptive assessment and stratified tasks, overcoming rote memorization in vocabulary learning, and effectively enhancing students' learning engagement and initiative.

2.2 The Supporting Role of Generative AI

Compared with traditional teaching methods, generative AI exhibits distinct advantages in English teaching, which can be summarized in four aspects. The first is personalization. AI can deliver differentiated materials based on students' language levels, learning preferences, and forgetting curves, perfectly following the goal of "one person, one plan". The second advantage is contextualization. Generative AI can provide students with sentences, discourses, and scenarios close to real life, enabling them to learn and understand the target vocabulary and its idiomatic collocations in specific contexts. The third aspect is immediacy and interactivity. AI can support diverse learning modes, offering answers, error correction, and feedback anytime and anywhere, overcoming the constraints of traditional face-to-face classroom learning and making timely feedback and correction feasible and reliable. The last aspect is datafication. AI platforms can record students' learning behaviors and generate data, graphs, or visualized learning reports, thereby providing objective diagnosis for teachers' instructional decision-making.

As far as vocabulary teaching is concerned, the supporting role of generative AI is mainly reflected in four aspects. First, AI can help reduce confusion in

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vocabulary usage through multimodal presentation and discrimination. Second, generative AI is conducive to developing students' autonomous learning ability by pushing strategy-based tasks. Third, generative AI can satisfy the requirements of stratified and personalized vocabulary learning by forming human–machine collaboration with teachers, thereby contributing to adaptive assessment. Fourth, generative AI can free teachers from tedious repetitive labor so that they can focus on instruction in higher-order activities. Admittedly, generative AI has its own limitations. Students may rely heavily on AI, which reduces their ability to summarize and reflect on their own problems and draw conclusions. Moreover, the materials pushed by AI tend to be over-generalized and do not closely align with students' actual proficiency levels. Besides, AI lacks emotional interaction with students. All these issues require teachers, the real organizers and instructors of class activities, to further design their classes and thus produce more productive and instructive vocabulary learning models.

2.3 The Research Focus of This Paper

Multimedia and smart teaching offer many advantages that English vocabulary teaching can draw on in designing classroom activities. Research on smart classrooms, generative AI, and vocabulary teaching has each yielded preliminary results. How to comprehensively utilize cutting-edge technologies to facilitate English learning and achieve the goals of college English instruction has become a pressing issue for researchers and teachers to tackle in practice. Nevertheless, few studies have effectively integrated these domains. To address this issue and bridge the gap, this paper first systematically reviews relevant research findings on college English teaching in China, and then proposes a human–machine collaborative teaching model empowered by generative AI. This model is implemented through a three-dimensional teaching model—"Multimodal Perception, Deep Construction, and Situated Transfer"—in an attempt to improve the effectiveness of English vocabulary teaching in real teaching environments. This study aims to address 4 problems—isolation, mechanicalness, fragmentation and monotony—troubling students and teachers in vocabulary learning and teaching.

III. TEACHING DESIGN AND FINDINGS

3.1 Design of the Teaching Model

This study is grounded in the teaching and learning difficulties confronting teachers and students. With human–machine collaboration as its design focus, it aims to build a vocabulary teaching model based on today's smart classrooms and various online platforms. Responding to the problems detailed in Section 1.2, the model consists of three dimensions: Multimodal Perception, Deep Construction, and Situated Transfer.

(1) The Multimodal Perception dimension

To address the problem of "isolation" and "mechanicalness" in vocabulary learning, this dimension utilizes generative AI to present authentic lexical chunks and audio-visual contexts for vocabulary use—pronunciation, form, and meaning conveyed through multiple modalities. Each modal exercise generally lasts one or two minutes, focusing on activating students' multi-channel perception and comprehension of vocabulary as it is "alive" in context and in their minds.

(2) The Deep Construction dimension

To tackle the problem of "fragmentation" in vocabulary learning, this dimension focuses on the deep processing and meaning construction of the target vocabulary, guiding students to integrate

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scattered words into their existing vocabulary network through activities such as semantic networks, word expansion through word formation, collocation schemas, and discrimination of synonyms and antonyms, thereby achieving a leap from point memorization to meaningful construction of word networks. Students are often required to complete the tasks within 5 minutes.

(3) The Situated Transfer dimension

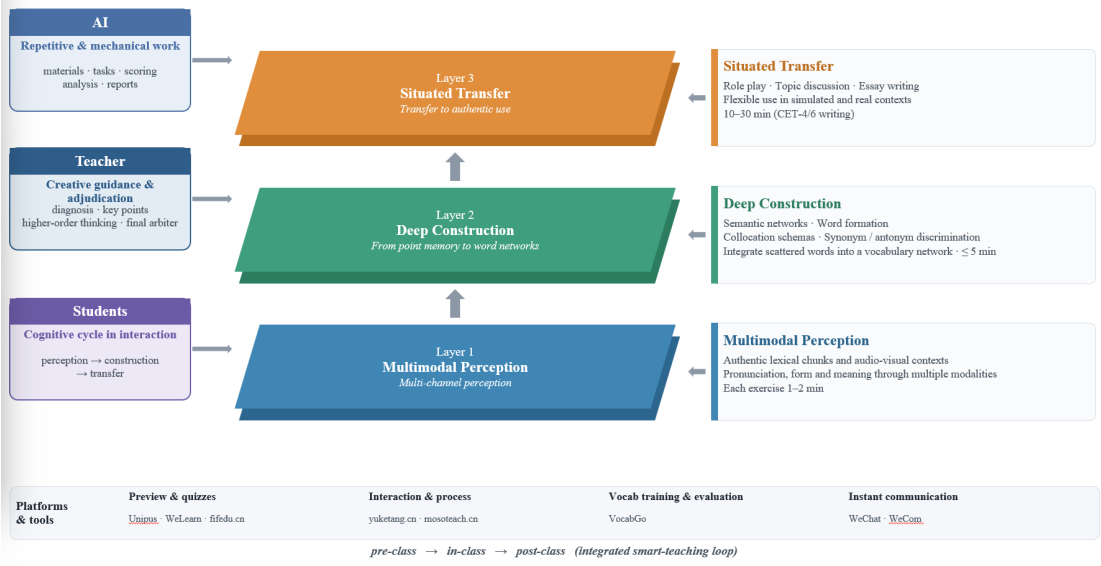
With regard to the "gap" between understanding and application, this dimension, through tasks such as role play, topic discussion, and essay writing, lays emphasis on the flexible use of the target vocabulary in simulated or real contexts, aiming at the transformation from mere memorization to appropriate use and thereby achieving idiomatic application of newly learned vocabulary. This dimension requires the students to devote more time and efforts to fulfill the tasks, running from in-class activities to post-class assignments, and time of essay writing may vary from 10 minutes to 30 minutes as those needed in National College English Test (CET) Band 4 and 6.

When it comes to human–machine collaboration, the three parties have distinct but complementary roles to play. AI undertakes repetitive and mechanical tasks, including the instant generation of contextualized materials, the delivery of personalized tasks, automatic scoring, data analysis, and the generation of students' learning reports. Teachers are responsible for creative work, including diagnosis of learning outcomes, identification and explanation of key and difficult points, and guidance of higher-order creative thinking. Students accomplish the cognitive cycle of perception, construction, and transfer during human–machine interaction. The three parties interconnect and constitute an integrated "pre-class—in-class—post-class" loop of smart teaching and learning.

The teaching model diagram can be accordingly drawn below (see Figure 1).

Figure 1

Three-Dimensional Interactive Teaching Model of College English Vocabulary Based on Human-Machine Collaboration



At the level of platform and tool support, the study fully utilizes well-accepted platforms such as Unipus, WeLearn, the textbook-matched "VocabGo", the school-based teaching and testing platforms: yuketang.cn, mosoteach.cn, and fifedu.cn, supplemented by social software such as WeChat and WeCom for instant communication. These platforms have their divisions of labor: Unipus, WeLearn, and

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fifedu.com undertake preview testing and quizzes; yuketang.cn and mosoteach.cn support classroom interaction and process recording; VocabGo is responsible for vocabulary training and automatic evaluation; and WeChat and WeCom are in charge of instant communication and Q&A between teachers, and students and among students. When the responsibilities of the three parties come into conflict, the teacher acts as the final arbiter.

3.2 Implementation of Teaching

This study collected data by combining a teaching experiment with a questionnaire survey. Two parallel first-year classes of non-English majors (science, chemistry, and engineering) at a university in China were randomly selected numbered 27 and 42 respectively; Class 42 served as the experimental class, in which the teacher adopted the human–machine collaborative three-dimensional teaching model, while Class 27 served as the control class, in which the traditional teaching model was the primary approach, with one semester as the experimental period. Each class consisted of 40–50 students, and the students in both classes had a vocabulary of approximately 3,000 words. Their average scores on the National College Entrance Examination were nearly identical. One teacher was responsible for all teaching activities in both classes, using a different teaching approach in each.

The data included pre-class quiz scores, unit vocabulary and reading test scores, scores on the vocabulary module of the mid-term and final test papers, platform learning-behavior data covering login frequency, task completion rate, and exercise accuracy rate, and questionnaire data. The study followed an integrated "pre-class—in-class—post-class" process, with the three-dimensional model running throughout.

(1) Pre-class stage: multimodal preview and intelligent diagnosis

Before class, the teacher posted course previews—the key points of the unit and the words and expressions needing students' special attention—together with multimodal learning materials, including video clips, audio pronunciations and explanations of target words, and background reading texts, on the school-based platforms yuketang.cn and mosoteach.cn. Students then completed corresponding test items based on the preview materials on the two platforms, including multiple-choice and banked-cloze items, to assess their grasp of the basic meanings, parts of speech, usage, and collocations of words. Thus, the materials students encounter were interconnected rather than isolated. Students were required to finish and submit the preview test on time, and they could check feedback on their performance. When confronted with difficulties, they could refer to the prompts provided by the platforms, discuss and exchange ideas with classmates, or turn to the teacher for help through social apps such as WeChat and WeCom. The teacher, based on the assessment data and feedback provided by the platforms, identified students' weak points, ascertained their actual mastery of the target language points, and determined the focus of class explanation, thereby forming a more personalized and targeted teaching plan.

(2) In-class stage: deep construction and situated transfer

Based on the preview data, the teacher decided the focus of explanation and organized classroom activities around the three dimensions. First, the teacher presented authentic discourses, images, or audio materials generated by AI, guiding students to observe the typical contexts, collocations, and semantic prosody of the target words (Multimodal Perception). Then, the teacher organized activities such as constructing semantic networks, discriminating synonyms and antonyms, and

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analyzing word formation to expand the use of the target words, guiding students in deep processing of the words to form a systematic vocabulary knowledge network (Deep Construction). Finally, the teacher assigned productive tasks, including role play, topic discussion, opinion elaboration, and short essay writing, to encourage students to use the target words in simulated and even real communication (Situated Transfer).

To be specific, the following example was taken from a unit titled "Water Resources" in the textbook. Before class, students gained a preliminary understanding of the target words through preview. In class, the teacher used an AI-generated discourse on water protection to introduce words such as "drought", "contaminate", "conserve", and "purify". Students were then required to pick out typical expressions in the audio and video materials and infer their collocations and semantic prosody from the discourse. Next, they drew semantic network diagrams, discriminated among near-synonyms such as "prevent/protect" and "conserve/reserve/preserve", and antonyms such as "scarcity/abundance", and "withdraw/recharge", finally engaged in group discussion and oral presentation on "Who is more responsible for water protection—individuals or the government?". Eventually, students wrote a short proposal to the university's Student Union to launch a "Water-Saving Week" on campus, thereby transferring and applying the learned words in authentic tasks and achieving the goal of "ample practice and timely feedback". Such writing practice also met the requirements of national English proficiency tests.

(3) Post-class stage: data-driven consolidation and remediation

The teacher assigned personalized vocabulary tasks through platforms such as WeLearn, mosoteach.cn, and VocabGo. AI automatically scored them and generated re-practice tasks for incorrect answers. Meanwhile, the teacher tutored weaker students individually based on the daily or weekly reports pushed by the learning apps and platforms, fulfilling the goal of "targeted remediation and timely correction". Throughout the teaching and learning process, data provided a primary reference for decision-making and activity design, forming a closed loop of "assessment—feedback—adjustment—re-assessment" and thereby achieving the organic unity of process-based management and assessment.

3.3 Teaching Evaluation and Feedback Mechanism

This study employed a multidimensional evaluation system combining formative and summative assessment, each accounting for 50 percent of the overall grade. Formative assessment data were derived from the automatic records of various platforms, covering preview scores, in-class performance, and the completion and accuracy rates of post-class assignments, together with indicators of students' learning behaviors such as login frequency and learning duration, thus tracking students' learning trajectories throughout the process. In contrast, summative assessment was primarily based on mid-term and final tests of students' vocabulary proficiency, taking into account both vocabulary size and quality, and covering collocation, semantic discrimination, and the use of words in specific contexts.

As for the feedback mechanism, AI brought its strengths into full play, shouldering such tasks as generating learning-situation reports and diagnosing wrong answers, achieving "immediate" assessment upon testing, and providing error correction and explanation as required. The teacher, based on these reports, provided timely explanations of common problems and individualized tutoring for specific ones, while students could access their personal

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learning profiles for self-monitoring and correction. Furthermore, the study adopted a multidimensional evaluation system to assess students' grasp of vocabulary—including self-assessment, peer assessment, and teacher assessment—so as to assess the quality of vocabulary use in creative tasks, rather than relying on the traditional model of a single examination determining everything, thereby using evaluation to promote learning and teaching throughout the process.

3.4 Experimental Results

After one semester of the teaching experiment, the experimental class outperformed the control class significantly on most indicators. First, in terms of vocabulary "size", the experimental class's average score on the vocabulary module of the final test paper was much higher than that of the control class, and its standard deviation was smaller, indicating a more balanced overall improvement in vocabulary. Second, in terms of vocabulary "quality", the experimental class outperformed the control class in collocation, semantic discrimination, and contextual use, effectively narrowing the gap between understanding and application. Third, in terms of learning-behavior data, the platform login frequency, task completion rate, and exercise accuracy rate of students in the experimental class rose continuously, which were persuasive indicators of enhanced learning engagement and initiative. Table 1, 2 and 3 presented the detailed results.

Table 1

Descriptive Statistics and Independent-Samples t-Test Results for Pre-test and Post-test Scores

Measure	Class 27 (n = 42) M (SD)	Class 42 (n = 46) M (SD)	Mean difference [95% CI]	t	df	p	Cohen's d
Pre-test	72.75 (5.72)	72.93 (5.30)	−0.17 [−2.51, 2.16]	−0.15	86	.883	−0.03
Post-test	69.67 (15.07)	82.80 (11.15)	−13.14 [−18.72, −7.55]	−4.61[a]	75.12	<.001	−1.00

Note. Mean difference = Class 27 minus Class 42; negative values indicate lower scores for Class 27. CI = confidence interval; d = Cohen's d based on the pooled standard deviation. Levene's test was not significant for the pre-test, F(1, 86) = 0.02, p = .878, so the pooled-variance t is reported. For the post-test, Levene's test was significant, F(1, 86) = 6.66, p = .012, so [a] Welch's t is reported; the corresponding pooled-variance result was t(86) = −4.68, p < .001.

Table 2

Paired-Samples t-Test Results for Changes from Pre-test to Post-test Within Each Class

Group	n	Pre-test M (SD)	Post-test M (SD)	Mean change [95% CI]	t	df	p	Cohen's dz
Class 27	41	72.87 (5.74)	70.17 (14.89)	−2.70 [−6.93, 1.53]	−1.29	40	.205	−0.20
Class 42	46	72.93 (5.30)	82.80 (11.15)	9.88 [6.40, 13.36]	5.72	45	<.001	0.84

Note. Mean change = post-test minus pre-test; positive values indicate improvement. For Class 27, one student's pre-test and post-test records could not be matched by student ID, so n = 41 for the paired analysis. CI = confidence interval; dz = Cohen's dz.

It was indicated that the two classes followed different trajectories. An ANCOVA controlling for pre-test scores confirmed a significant group effect on the post-test, $F(1, 84) = 21.94$, $p < .001$, partial $\eta^2 = .207$; adjusted means were 70.19 for Class 27 and 82.79 for Class 42.

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Table 3

Online Learning Engagement and Practice Performance on the WeLearn Platform

Class	n	Mean Online Duration (min)	Mean Logins	Practice Accuracy (%)	Course-Learning Effort Points	Other Effort Points
Class 27	42	629.3	22.9	62.8	5041.7	1493.6
Class 42	46	759.5	25.6	78.8	6051.1	1789.3

Note. Values are class means. WeLearn is the online self-study platform used in this study. Effort points are platform-generated indices of learning effort: course-learning effort points refer to effort invested in the course modules, and other effort points refer to effort invested in other platform activities. Practice accuracy is the percentage of correctly answered practice items.

In the questionnaire survey, most students believed that AI-assisted vocabulary learning was more contextualized, targeted, and interesting, which greatly boosted their learning motivation. From the teacher's perspective, AI-aided, data-driven teaching made instruction more evidence-based and feedback more timely, significantly improving teaching efficiency. On the whole, human–machine collaborative teaching empowered by smart platforms and generative AI is conducive to the development of students' vocabulary competence and, in turn, to their overall language proficiency.

IV. CONCLUSION

Based on the experimental results and on teaching experience, human–machine collaborative teaching empowered by generative AI, with the "Multimodal Perception—Deep Construction—Situated Transfer" three-dimensional model as its carrier, infuses AI into traditional classrooms, significantly alleviating the long-standing problems of isolation, mechanicalness, fragmentation, and monotony in college English vocabulary learning and teaching, effectively enhancing students' engagement and vocabulary competence, and eventually promoting the development of reading, writing, and overall language proficiency. The study demonstrates that AI-assisted college English vocabulary teaching and AI-enhanced college English classes show great promise in the modern information age and are likely to be an important direction for future teaching development.

Of course, it must be admitted that this study has its limitations, such as not completely randomly-chosen classes, a limited sample size and a relatively short experimental period. In addition, it is assumed that, between the two classes, factors such as students' long-term learning motivation, classroom management, and external interference remain constant. Furthermore, the accuracy and appropriateness of AI-generated content still require teachers' supervision, and the appropriate "degree" of human–machine collaboration requires further exploration in practice. Future research can expand the sample, extend the period, examine the differential effects on students at different levels, and explore the in-depth integration of generative AI with the teaching of listening, speaking, reading, and writing, so as to further verify the effectiveness of such integration.

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