Journal of Teaching Innovation and Practice
teaching-and-research.jtr-nsp.com

Article

Exploring the Effectiveness of a Symbiotic Human-Computer Collaborative Model in College English Teaching

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Citation: Wei, X. (2025). Exploring the Effectiveness of a Symbiotic Human-Machine Collaborative Model in College English Teaching. *Journal of Teaching Innovation and Practice*, *1*(2), 1–8. https://doi.org/10.65170/jtr.v1i2.24

Abstract: With the latest progress and extensive application of AI in recent years, the educational sector has never experienced such a huge transformation. As a new teaching mode based on artificial intelligence technology and teacher's subject knowledge that has been applied to College English classroom, human-machine collaboration teaching model has been applied to English classroom. This study is based on theory of symbiosis to establish and practice a "teacher-student-machine" human-machine teaching model applicable to college English teaching. The experiment continued for 12 weeks, pre-test and post-test were carried out to compare students' academic performance and deep interviews of one teacher and nine students from experimental group were made to collect their opinions and comments about this teaching model. The above results are found to illustrate that this type of model can not only effectively enhance students' English grade, but also stimulate teachers' professional development and role mutation, and initially construct teachers, students and intelligent machine's mutual-beneficial and symbiosis teaching ecosystem.

Keywords: Symbiosis Theory; Human–Machine Collaboration; College English; Interviews

1. Introduction

AI is widely applied into people's daily life, work and study, gradually changing the situation of College English teaching. Although various kinds of AI tools are applied on teaching platforms in the education field, they are just used to play separate roles rather than a series of teaching innovation. As pointed out by Chen Lin and Hu Wenzhong (2022), an "authoritative" teaching style drags the students' engagement and leads to a one-sided contact in the classroom. Similarly, Guo Jia (2023) found that AI implementation so far failed to completely change the classroom structure as teaching processes still lack systematic design and feedback loops. Mustafa (2024) also commented that while AI is being used more and more often in education, its use is typically technologically standalone without an integration point into more traditional styles of teaching.

Teacher training, ethical frameworks, and curriculum reconstruction are identified as the key bottlenecks in the educational integration of AI. Wang (2024) also noted that teacher professional development, curriculum reconstruction, and systems thinking are all essential for integrating AI. However, in reality, most schools and classrooms remain at the stage of tool adoption rather than teaching process reconstruction. Just as Crompton (2024) pointed out, although a variety of AI tools have been introduced into English language teaching, "their application is still at an early stage, and teachers and students differ in their understanding and use of them." The core challenge faced by many frontline teachers is not the lack of technical tools, but the absence of a set of teaching logic and practical plans that can clarify the relationships among "teachers", "students", and "machines" and realize the complementarity of their advantages. This study argues that the ultimate goal of human-machine collaboration should not be "machines replacing teachers" or "teachers controlling machines", but rather building a positive teaching ecology where the three parties coexist harmoniously and evolve in collaboration. To this end, symbiosis theory is introduced as the core analytical framework. Compared with pursuing complex quantitative data verification, this study focuses more on the lived experiences and emotional responses of participants in teaching reform. Such an approach aligns with the view that educational transformation should be understood through the subjective experiences of teachers and learners rather than through numerical indicators (Barkhuizen, 2016; Gao & Xu, 2014; Shi, 2023; Yip, 2022). A quasi-experiment was conducted to create a comparative context, and on this basis, in-depth interviews with participants—especially a teacher who was deeply involved—were carried out to explore in-depth the practical logic, emotional experiences, and intrinsic value under the human-machine collaborative symbiosis model. This study aims to answer the following questions:

a. What is the core operational mechanism of the human-computer collaborative teaching model constructed based on symbiosis theory?

b. How do participants (teachers and students) experience and assess this model?

c. In what ways does the model fundamentally reshape teaching practices and learning engagement?

2. Educational Applications of Symbiosis Theory

The concepts of symbiosis theory are first introduced in biology, to depict the long-term interactions between different species in one environment through resource complementation and functional complementation of species according to existing conditions such as environment and regulation conditions (Margulis, 1998). In the decades since, scholars have broadened this perspective to social fields like sociology (Tilly, 1978), ecology (Lawton, 2004) and education to explore why a complex system's multiple constituents mutually adapt to each other over time through their sustained interactions (Capra & Luisi, 2014).

Under the setting of formal education, teachers, students, and AI tools could be seen as three mutual-related "symbiotic units" that sustain a learning system. They share three distinctive but intertwined "ecological niches", which is linked with each other in the collaborative network of knowledge-building, meaning-making, and learning-assisting (Zhao & Zhang, 2023).

In this light, teachers go beyond being "information providers" to facilitators of the goals of learning, participants of learning values' construction, and managers of cognitive schemes. Learners mature and become self-conscious co-creators who interpret and put learning content into practice in diverse situations. In parallel, intelligent machines offer a technical substrate for scalable content generation, instant feedback, diagnostic evaluation, and personalized teaching design (Crompton et al., 2024). The three-level mutually-adaptive framework changes learning from unidirectional communication into a two-way co-evolution, for mutual understanding and feeling between men and machines (Mustafa, 2024).

At the educational level, this perspective yields three principal implications:

a. Ecological Interdependence

The learning ecology should focus on mutually supporting and resource complementary interaction between teachers, students and AI, instead of the technological supremacy. The dynamic equilibrium state of the learning ecology is formed as actors become mutually adapted in the mutually-supporting and mutually-responsible way (Wang et al., 2024).

b. Co-evolution of Human and Machine Intelligence

Learning exercises featuring nested feedback and interactive tasks can also advance the cooperative evolution of human brains and artificial agents, as cooperative learning helps both humans and AI tools improve solution skills and their problem solving capabilities over time.

c. Ethical Co-governance

Ultimately, using AI in education calls for technological development that is shaped by principles of ethics. A guiding principle of ethics means shaping technological development according to a broader value system of humane action and enhancing the idea of equity, inclusion and educational justice (UNESCO, 2023).

In so doing, Symbiosis Theory provides a theoretical framework to make sense of the mutually interacting roles of human–AI–education triad as one evolving system and unveils how teaching and learning can be reconfigured during the digitalization processes. Originally proposed for the natural sciences to explain the stable relationship between differ rent species that exist in a mutually beneficial partnership, applied to education the theory considers teacher, learner and AI-tools as fundamental symbiotic agents. In an established symbiotic system, they cooperate, enabling a collectively adaptive form design for a maximized learning effectiveness—a state of the phenomenon known as mutualistic symbiosis.

3. Research Design and Methods

This study adopted a mixed research design to gain a comprehensive understanding of the research question. The quantitative phase aimed to objectively measure the learning outcomes of the two teaching models through pre-test and post-test scores. Qualitative research design was employed in this work and semi-structure in-depth interviewing was used as the primary source of data. To complement qualitative interview data and objectively measure teaching effectiveness, a quasi-experimental quantitative framework was integrated, focusing on language competence and collaborative learning engagement as core evaluation indicators.

3.1 Participants and Setting

Teaching Context

The experiment was conducted on two first year undergraduate groups in a Chinese university. One group was the experimental group (n=50), and the other was the control group (n=50). Both classes were taught by the same English teacher using the same textbook.

The control group adopted the traditional multimedia-assisted teaching mode, while the experimental group employed the “three-stage” human-computer collaborative teaching mode based on the symbiosis theory. The intervention period lasted for 12 weeks. Both groups were taught by the same teacher, which helped control the teacher-related variables and thereby increased the credibility of the experimental result differences being attributed to the teaching mode itself.

For interview participants: Ten participants from the experimental group were selected via purposive sampling for interviews After the intervention.

One teacher: the instructor who implemented the model.

Students: nine learners representing high, medium, and low proficiency levels, identified through academic performance and teacher referral.

For quantitative process: Quantitative Measurement Tools include English Language Proficiency Test and Collaborative Engagement Questionnaire. They are administered to both groups. CET4 is a standardized test, covering listening, reading, writing, and translation (total score: 100). Collaborative Engagement Questionnaire is self-designed with 15 items (5-point Likert scale) to assess students' participation in human-computer collaborative activities (e.g., "I actively interact with the AI tool to solve learning problems").

Pre-test (before intervention) and post-test (after 12-week intervention) used parallel versions with consistent difficulty, verified for reliability (Cronbach's $\alpha = 0.87$) and validity via expert review.

3.2 The "Three-Stage" Symbiotic Model

When the model was built, the "technology-centered theory" or the "teacher-centered theory" was abandoned. However, humans and machines are seen as an inseparable symbiotic unit. In this model, teachers act as the designer of teaching, the guide of emotions, the stimulator of higher-order thinking, and the decision-maker in human-machine collaboration. "Machines" play the role of personalized knowledge provider, a recorder of the learning process, an analyst of student data, and an automaton executor of some repetitive tasks. At the same time, students are active constructors of knowledge, experimenters in the learning process, and feedback providers for teaching effectiveness. This teaching model defined the roles and interactions of each symbiotic member—teacher, student, and machines—throughout the instructional process.

Pre-Class: Intelligent diagnosis and precise presetting (Asynchronous Symbiosis)

During this stage, teachers will use AI tools to generate customized learning resources, in order to better meet the diverse needs of students. At the same time, students utilize the personalized learning scaffolds provided by AI tools to conduct independent exploration during the process. Teachers design tasks with AI-generated customized resources (T–M collaboration). Students conduct self-directed learning with AI scaffolding (S–M exploration). Meanwhile, the system will transmit the diagnostic feedback data it has analyzed to the teachers, providing them with a solid basis for their subsequent teaching decisions. (M–T feedback).

In-Class: Cooperative Teaching and Dynamic Intervention (Synchronous Symbiosis)

The classroom is no longer dominated by the teacher's single voice. The teacher is responsible for creating the context, guiding the exploration, organizing collaboration and providing in-depth explanations. At the same time, the system intervenes in real-time: Based on the feedback from students' in-class exercises, it sends "common mistakes focus" to the teacher's end or "personalized prompts" to the students' end. In this stage, teachers and machines complement each other, jointly forming a student-centered, teaching organic whole.

Post-Class: Personality Expansion and Cyclical Evolution (Ubiquitous Symbiosis)

The post-class stage is an extension and deepening of learning. Through AI-generated learning reports, teachers can quickly identify students who need help and provide them with one-on-one tutoring or design project tasks that stimulate creativity. All these learning data are systematically recorded to provide precise basis for the design of the next class. Thus, teaching is continuously improved under the guidance of data, forming a dynamic learning cycle consisting of AI assigning personalized tasks, students exploring independently, and teachers providing full support throughout.

3.3 Data Collection and Analysis

The researcher compared the academic performance of the students before and after the experiment according to the behavioral data, analyzing indicators such as the duration of students' study time, the click rate of resources, the accuracy of homework, and the speed of error correction recorded on the platform. Besides, all participants from the experimental group and the control group took a standardized English proficiency test. This test served as a pre-test to ensure that there were no significant differences in the English proficiency of the two groups before the implementation of the intervention measures. The test covered key abilities such as listening, reading, vocabulary, and grammar, with a total score of 100. After the 12-week intervention period, all participants took the final exam as a post-test. This exam was designed by the university's teaching team and was consistent with the course objectives and the content covered during the semester. The average values and standard deviations of the pre-test and post-test scores of the two groups were calculated to provide an overall overview of the data.

The interview is the core part of this research, aiming to deeply explore the “why” and “how” behind the quantitative data, and directly respond to research questions two and three. All data analyzed here was from semi-structured interviews. The teacher was interviewed twice—half and upon completion—and each was an hour long in order to follow-up changing perceptions and practices. Students had group and one-on-one interviews that covered: (i)overall impressions of the model, (ii) role shifts and behavioral adjustments, (iii) perceived difficulties and gains, (iv) understanding of the relationships among teachers, students and AI tools.

Regarding analytical methods, the Braun and Clarke (2006) thematic analysis method was adopted: repeated reading for deeper understanding, initial coding, theme identification and refinement, and final theme definition. In this study, a detailed case analysis of the teachers' interviews and students' interviews were conducted.

4. Findings

The quantitative data shows that the two groups started with very similar pre-test scores. After the 12-week intervention, both groups showed improvement. However, the experimental group's post-test mean score was substantially higher than that of the control group. Through a comprehensive analysis of quantitative data and interview texts, the following conclusions to answer the three research questions are drawn.

For research question one: the core operational mechanism of this model-namely, the “data-driven diagnosis and human-machine intelligent intervention” loop - has been clearly elucidated at the theoretical level in 3.2. After that, an empirical examination of the feasibility and effectiveness of this mechanism in practice was carried out mainly by analyzing specific classroom performances, conducting in-depth interviews.

For research question two: In terms of teachers, their decision-making basis is shifting from relying on “teaching intuition” to placing greater emphasis on “empirical data”. They are evolving into a personalized “learning designer” and “thinking guide” for students. Even though there were challenges related to adapting to the new technology during the initial stage of transformation, most teachers eventually discovered that technology could free them from repetitive tasks, allowing them to focus more on creative and humanistic teaching interactions.

For students, the most significant experience is the fact that their learning has achieved an unprecedented level of “adaptability”, emotional guide and “sense of support”. Immediate feedback is like a constant study partner by their side, which effectively dispels their confusion and enhances their control over the learning process. This enables them with more abilities to continuously take on challenges, while also providing timely support to those who are temporarily behind, helping them regain their confidence. At the same time, their connection with their teachers has shifted more towards emotional support and the collision of complex thinking, making the relationship deeper and more meaningful.

In the role of emotional support, student accounts provided clear evidence. One lower-achieving student remarked:

“I felt discouraged when the AI repeatedly highlighted my grammar errors. But the teacher acknowledged my idea first, then helped me find the answer collaboratively. That made me feel respected.”

For research question three: In terms of teachers, this is the reshaping of the teaching paradigm, because the teaching process, in which its decision-making mechanism was only controlled by the teacher in the traditional classroom, has evolved into a human-machine intelligent collaboration based on data. In addition to that, the evaluation method has changed from a static outcome-based assessment to a comprehensive assessment which focuses on the whole learning process and development of students' abilities.

For students, this is the reshaping of learning engagement, because students' learning engagement has evolved from passive behavioral compliance to strategic cognitive self-regulation and positive emotional investment, which is driven by a learning environment that understands their needs. Just like a mid-level student noted in the interview:

I mainly listened to the lectures and took notes in the past. However, at present, I prepare my study in advance, participate in discussions, and complete the follow-up tasks. This requires me to study more initiatively, and I feel that the knowledge are truly mine - discovered and mastered by myself.

In a word, the analysis of the interview data revealed three core themes, which reflect the teaching dynamics in the classroom where humans and machines coexist: Firstly, teacher's role has been transformed from authoritative figure to course designer and learning guide; Secondly, students have changed from passive knowledge receivers to active learners; Thirdly, true human-machine symbiosis in the field of education could only take root and thrive in a fertile soil, which consists of a solid technological infrastructure and a supportive, adaptable institutional culture, according to the experiment.

5. Conclusion and Implication

This model, which was divided into three stages (pre-class, in-class, post-class), provides a clear collaborative framework for the interaction among teachers, students, and artificial intelligence tools. It replaces the ambiguity and uncertainty with the clear delineation of each role and the interdependent relationship among them. This model realizes the exchange of energy within the symbiotic unit: "Data-based diagnosis" is understood as the "energy" that the machine conveys to the teacher, while "the teacher's intelligent intervention" is understood as the "energy" that the teacher conveys to the student. Meanwhile, students' active participation and progress are seen as new "energy" fed back to this symbiotic system, which perfectly illustrates the mutualistic nature of the symbiotic relationship. In this mode, the "machines" plays a more proactive "collaborator" role, which indicates that within the framework of the symbiosis theory, the human-machine relationship should be elevated from "utilization" to the level of "symbiosis".

Therefore, it achieved collaborative cooperation and complementary activities rather than competition, so the effect produced by this triple collaborative interaction exceeds the combined effect of the individual components, resulting in a new phenomenon of "1 + 1 + 1 > 3".

The core of this symbiotic model lies in the profound transformation of the role of teachers. Evidence shows that teachers have not been replaced by technology. Instead, they have been elevated to a new level of professional practice. Teachers have transformed from the primary providers of information to the designers of learning experiences, the facilitators of collaborative dynamics, and the mentors for the comprehensive development of students. This transformation has not diminished their significance; instead, it has reinvigorated their profession by leveraging human unique capabilities (such as empathy, moral judgment, and creative inspiration), which are beyond the reach of artificial intelligence. Therefore, this redefined role is a key driving factor for successful and systematic reforms in technology-enhanced learning environments.

This model aims to construct a balanced educational ecosystem to promote the co-evolution of machine intelligence and human wisdom. Empirical data show that in this ecosystem, artificial intelligence utilizes its computing and data processing advantages to provide precise and scalable intelligent support; teachers, with their professional teaching abilities and emotional understanding, effectively promote students' deep reflection and character development; in this environment, students' academic performance, autonomous learning ability, and confidence in innovation all show significant progress. The core proposition of this model is that technology should enhance rather than replace human capabilities. Ultimately, a mutually reinforcing synergy is formed between teaching art, learning skills, and technological efficacy, jointly achieving the educational goal of mutual benefit and promoting overall development.

Future studies could employ longitudinal designs to assess the model's long-term impact on critical thinking, creativity, and intercultural communicative competence. Comparative case studies across different disciplines would also be valuable to explore the contextual adaptability of the symbiotic framework.

DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this article. The data that support the findings of this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

Xuemei Wei: Conceptualization; investigation; writing – original draft; methodology; review and editing.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the financial and instructional support provided by the association, which made this research possible.

FUNDING:

This research is supported by the Sichuan Cognitive Linguistics Research Association under Grant NO. SCRY2024GJ11.

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