

A Study on Enhancing Student Cognitive Engagement in AI-Empowered College English Teaching from the Perspective of ICAP Theory

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Abstract: Current college English classrooms often face challenges such as superficial cognitive engagement and formalized interactions among students. However, generative artificial intelligence presents a significant opportunity to reconstruct the educational ecology. This paper, grounded in the ICAP framework of learning modes, examines pathways for AI-empowered college English instruction aimed at enhancing students' cognitive engagement. The study develops a smart teaching model characterized by "data-driven, human-machine collaboration," which transcends the traditional tool role of AI and positions it as a learning partner within the knowledge network. By designing progressive teaching tasks aligned with each ICAP level (Passive, Active, Constructive, Interactive), the model guides students toward achieving higher-order cognitive input through collaboration with AI. Research indicates that this model can effectively transform students from passive recipients of knowledge into active explorers of knowledge, significantly improving deep classroom engagement and higher-order thinking skills. This provides both a theoretical reference and a practical paradigm for reconstructing the foreign language teaching ecology in the AI era.

Keywords: ICAP theory; College English teaching; Artificial intelligence; Cognitive engagement

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1. Introduction

In the long-term frontline teaching practice of college English, it is evident that despite years of educational reform, the classroom ecology has not experienced fundamental changes. The current English classroom is generally characterized by a predicament in which teachers primarily deliver one-way instruction while students passively receive information. Often, in an effort to enliven the atmosphere, teachers design group discussions or role-plays; however, due to the lack of genuine communicative meaning and cognitive challenges, these interactions tend to be superficial, becoming a "nightmare" for the students called upon and an opportunity for others to disengage^[1]. The uniform content and pace inherent in large-class teaching further contribute to the insufficient individualized development of students, significant disparities in learning motivation, and the frequent occurrence

of classroom “silent participants.” This shallow participation directly undermines students’ learning agency, transforming language knowledge into inert storage rather than facilitating active output.

In recent years, the rapid development of generative artificial intelligence and large language models has presented an unprecedented opportunity to overcome this dilemma. However, in practical applications, we often find ourselves in a quandary: either we superficially integrate AI merely as an enhanced tool without addressing the fundamental structure of teaching, or we risk students utilizing AI as a high-level “ghostwriter,” which can lead to a decline in learning motivation and impaired independent inquiry abilities ^[2]. To truly unlock the transformative potential of AI, we must transcend its instrumental application and shift teaching from “technology empowerment” to “ecological reconstruction”. In light of this, this study seeks to introduce the ICAP learning mode classification framework to explore a systematic approach for AI-empowered college English teaching, with the aim of transforming AI from an auxiliary tool into a deeply engaged structural element, promoting students’ comprehensive involvement in behavioral, cognitive, and emotional dimensions, and achieving a fundamental shift from “formal interaction” to “meaningful participation.”

2. Introduction and applicability of the ICAP theoretical framework

The ICAP framework, proposed by Professor Michelene T. H. Chi, a member of the American Academy of Education Sciences ^[6], is a highly influential theory of cognitive engagement within the field of international educational psychology. This framework categorizes students’ interactions with learning materials into four modes: passive, active, constructive, and interactive. In the passive mode, students merely receive information, and knowledge is stored in an isolated form; in the active mode, students activate existing knowledge and integrate it by manipulating materials (e.g., underlining, rehearsing); in the constructive mode, students generate new knowledge that extends beyond the provided materials through inference, achieving knowledge transfer; in the interactive mode, students engage in collaborative dialogue to jointly infer and co-create knowledge. The core hypothesis of this framework posits that learning outcomes follow a progressive relationship of $I > C > A > P$, indicating that higher engagement leads to improved learning outcomes.

In the context of AI-empowered college English teaching, the ICAP framework demonstrates high applicability and guiding value. For an extended period, college English instruction has predominantly remained at the passive and active stages of lower-order thinking, with students preoccupied with memorizing vocabulary and applying grammatical rules. Without a scientifically informed design, the integration of AI technology can easily lead students into a “path dependency” on large models, potentially resulting in a decline in genuine critical thinking^[5]. The ICAP framework offers a valuable tool for cognitive diagnosis and instructional design. It enables teachers to accurately assess the cognitive stage of students by observing their overt behaviors. More importantly, when combined with connectivism theory, we can position AI as a crucial node within the knowledge network. Through thoughtfully designed human-computer collaborative tasks, students are guided to transition from passive knowledge recipients to active manipulators, constructive critics, and ultimately to interactive co-creators. This approach not only serves as an effective discipline of technological tools but also profoundly stimulates students’ cognitive engagement.

3. Construction of an AI-empowered college English teaching model from the perspective of ICAP

Based on the theoretical framework presented above, this study constructs a novel model of AI-enhanced

college English teaching from the perspective of ICAP. This model aligns with the progression of students' cognitive levels and thoroughly integrates AI into the instructional design at various cognitive stages.

At the initial stage of low-level thinking, specifically within the realms of passive and active learning, AI primarily serves as a 'resource provider' and 'corpus generator.' In traditional teaching, textbook content is often fixed and highly homogenized. However, educators can now utilize AI generative large models to transform 'limited textbooks' into 'unlimited corpora.' For instance, in reading instruction, teachers establish the theme, difficulty, and vocabulary list, allowing AI to automatically generate parallel texts of varying difficulty levels, thereby facilitating tiered reading with 'one article, three levels of difficulty' ^[4]. During this stage, students engage with AI-generated multimodal materials by browsing, marking unfamiliar words, and completing basic vocabulary challenge games. Although this still falls within passive or active participation, AI's personalized delivery effectively reduces students' cognitive load, thereby establishing a foundation for the development of higher-order thinking.

At the stage of higher-order thinking, namely the constructivist and interactive learning levels, the teaching model undergoes a fundamental transformation. In constructivist learning, educators should design tasks that compel students to process information critically. For example, in English writing training, an "AI Creative Stimulator" task is introduced, where students direct AI to generate a draft or argumentative framework for an essay, subsequently taking on the role of "editor-in-chief" to fact-check, deepen the logic, and individually refine the AI-generated content. In addressing potential "hallucinations" or cultural biases from AI, teachers guide students to critically evaluate the content and develop their own cross-cultural understanding reports. This process encourages students to evolve from passive recipients of knowledge into active creators of knowledge. In the realm of interactive learning, AI-supported peer collaboration becomes pivotal. Educators can leverage online collaborative platforms to facilitate group work in writing outlines, with the platform's integrated AI assistant providing real-time polishing suggestions. More importantly, the system can randomly assign anonymized drafts to other groups for structured peer evaluation based on predetermined criteria, enabling students to achieve collaborative knowledge creation through alternating discourse and the exchange of differing ideas ^[1]. In this context, AI is not merely a tool but a catalyst that fosters collaborative reasoning among students.

4. Practical strategies for enhancing cognitive engagement with AI in college English education

The implementation of theory necessitates well-defined practical pathways. In specific teaching contexts, educators should systematically engage in efforts across the three stages of pre-class, in-class, and post-class to establish a closed loop.

In the pre-class phase, data-driven intelligent learning diagnostics serve as the foundation. Educators should utilize multimodal data collection and learning analytics to accurately ascertain each student's cognitive starting point and interest preferences through pre-class assessments and platform logs. Based on this data, educators no longer rely solely on intuition to infer learning conditions; instead, they establish differentiated teaching tasks according to the overall knowledge heatmap of the class, thereby laying the groundwork for personalized instruction. For instance, if the system identifies that students frequently make errors in causal logical connectors in academic writing, it can automatically generate targeted discriminative practice micro-lessons, integrating specific knowledge points into the learning trajectory ^[3].

During the in-class phase, the establishment of a "dual-brain classroom" to enhance human-machine

collaborative teaching is crucial. In the human-machine collaboration model, the biological brain and the AI digital brain collaborate closely through a rational division of labor. The biological brain focuses on emotional communication, intuitive judgment, and value guidance throughout the English teaching process, while the digital brain concentrates on computational analysis, information processing, and extensive data storage. In practical implementation, prior to class, the digital brain deploys assessment tools to generate learning reports, based on which the biological brain identifies key and challenging points; during class, the biological brain creates scenarios and elucidates concepts, while the digital brain is tasked with presenting resources to students and supporting group inquiry; in the outcome presentation session, the digital brain assesses learning effectiveness, and the biological brain raises expectations for students' innovative thinking. This model transforms the classroom into a dynamic, responsive intelligent learning ecosystem, ensuring that interactions are not only vibrant in form but also conducive to the cognitive growth of each individual.

In the post-class phase, the implementation of dynamic assessment and the “assessment-intervention” closed loop is vital. Traditional assessments often depend on final written exams, which provide delayed feedback and complicate the tracing of the learning process. AI can construct an “invisible sensing network” that spans pre-class, in-class, and post-class phases, generating visual analysis reports from behavioral, cognitive, and emotional dimensions. Based on comprehensive diagnostics, the system executes personalized resources to achieve precise consolidation tailored to each student. Simultaneously, for “potential disengagers” exhibiting a continuous decline in participation or negative emotional signals, the system proactively alerts educators, prompting them to provide timely support and academic guidance. Additionally, to address challenges related to academic integrity, a “transparency contract” mechanism must be established, requiring students to clearly articulate the purpose, interaction process, and their own contributions when submitting AI-assisted assignments, thereby fostering the development of their metacognitive abilities.

5. Evaluation and reflection on teaching effectiveness

To scientifically evaluate the implementation effectiveness of this model, teachers should adopt a mixed-methods assessment framework. Quantitative evaluation primarily relies on the learning analytics modules embedded within the intelligent teaching platform, focusing on observable behavioral indicators such as speaking frequency and task completion rates, supplemented by questionnaire surveys to measure changes in students' learning interest and anxiety levels. Qualitative evaluation employs in-depth interviews and classroom observations to document actual shifts in teacher-student interaction patterns and classroom discourse structures. Expected results indicate that, in terms of behavioral engagement, AI-driven real-time interaction is likely to significantly reduce the phenomenon of “silent students”; in cognitive engagement, the complexity of tasks handled by students will increase, exhibiting stronger higher-order thinking traits; in emotional engagement, the low-risk AI practice environment can effectively alleviate speaking anxiety and enhance the sense of learning control ^[1].

However, in the process of advancing AI empowerment, we must also maintain sober reflection. The first issue is technological adaptability. Existing AI systems still have limitations in natural language processing, especially when handling content involving specific cultural contexts, and struggle to provide absolutely precise interpretations. The “hallucination” problem of AI requires teachers to possess a higher level of digital literacy, enabling them to guide students in fact-checking. Secondly, over-reliance on technology may lead to a decline in students' ability to think independently and judge in English. If cognition is outsourced to AI, the core value of information literacy education will be marginalized. Therefore, teachers' professional literacy must evolve from a traditional binary structure to

a composite one that includes technology integration and ethical reflection. We need to adhere to the educational essence of “technology serving humanity” in human-machine collaboration, establish an interpretable evaluation system, and ensure that the evaluation process is open, transparent, and reasonable, so as to counter the ethical challenges brought by technology and promote a culture of responsible innovation.

6. Conclusion

Artificial intelligence technology is reshaping the ecological landscape of college English education, with its impact extending deeply into the innovation of teaching models and educational philosophies. Based on the ICAP theoretical framework, this study explores the pathways for AI-empowered college English teaching and the enhancement of student cognitive engagement. By constructing a teaching model that spans from lower-order to higher-order thinking and implementing an integrated practical approach before, during, and after class, we strive to transform AI from a mere tool into a partner that promotes deep student engagement. Although challenges remain in areas such as technological adaptation and the digital literacy of both teachers and students, the digital transformation of education is an irreversible trend. As educators, we should embrace technological change with an open and inclusive attitude, while exploring new paradigms in the dialectical unity of technology and humanities, contributing to the cultivation of international talents with global competence and higher-order thinking skills.

Disclosure statement

The author declares no conflict of interest.

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