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Article

Toward an Integrated Framework for Understanding and Guiding Human-AI Collaboration in Secondary School EFL Teaching

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Abstract: This study explores the impact of human-AI collaborative teaching strategies on English teachers in secondary schools. Based on semi-structured interviews with five English teachers in Jiangxi Province, thematic analysis was conducted using the SAMR, UTAUT, and GHEX-IPACK theoretical frameworks. The findings indicate that AI technology is primarily applied in scenarios such as resource generation, assignment distribution, and learning analytics. By substituting traditional tools, enhancing teaching interactions, and reconstructing instructional processes, AI facilitates a shift in teaching strategies from "teacher-led" to "human-AI collaboration". Teachers generally recognized the potential of this model for improving efficiency and supporting personalized learning, but also pointed out challenges, including data bias, hardware limitations, and a lack of emotional interaction. The study suggests that achieving deep human-AI collaboration requires balancing technological efficacy with humanistic care relying on blended instructional design and teacher training to optimize teachers' knowledge structures. This research preliminary constructs a practical model of human-AI collaboration in secondary school English education, providing insights for teacher professional development.

Keywords: human-AI collaboration; artificial intelligence in education; teaching strategies; SAMR; UTAUT; GHEX-IPACK

1. Introduction

Artificial intelligence (AI) is transforming education by advancing human-AI collaboration beyond basic assistance towards enhancement, integration, and co-creation (Zhu et al., 2023). AI now acts as a "cognitive partner" in core teaching instructional activities. Zhao et al. (2025) found that AI-based reflective dialogue significantly enhances EFL students' oral proficiency by creating a "Dialogue-Reflection-Enhancement" learning cycle. This underscores the need to rethink the teacher's role—from knowledge deliverer to learning designer and human-AI collaborator—and highlights the importance of developing teachers' digital literacy to effectively foster student competence in AI-enhanced classrooms.

Against this backdrop, this study employs the SAMR, UTAUT, and GHEX-IPACK frameworks to investigate the transformation path of human-AI collaborative teaching strategies among secondary school English teachers. The specific research objectives are:

(1) To map practical pathways: Using the SAMR model to reveal application scenarios and integration levels of human-AI strategies across teaching preparation, implementation, and assessment.

(2) To analyze adoption motivations: Drawing on UTAUT theory to identify key factors influencing teachers' adoption and to evaluate the model's advantages and limitations.
(3) To construct a practical paradigm: Applying the GHEX-IPACK framework to analyze the reconstruction of teachers' knowledge structure and to build an education-led, ethics-embedded collaborative paradigm for the GenAI era.

2. Literature Review

2.1. Theoretical Foundation

This study employs a tripartite theoretical framework to systematically examine human-AI collaborative teaching. The frameworks are logically connected: they address the level of integration, the motivation for adoption, and the knowledge required for effective implementation.

First, the SAMR model (Puentedura, 2009, 2020) provides a lens to categorize the depth of technology integration in teaching practice, ranging from simple Substitution and Augmentation to transformative Modification and Redefinition presented as Figure 1. SAMR Model. (Blundell et al., 2022). It answers the fundamental question of what technology can do to change learning tasks.

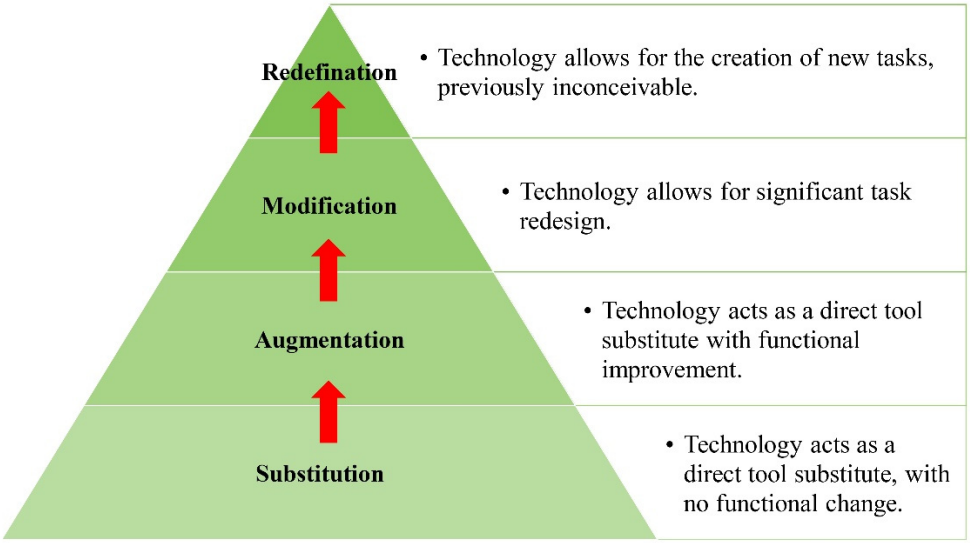

Figure 1. SAMR Model.

To understand why teachers adopt or resist such integration, this study draws on the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). Its core constructs—Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions—offer a robust model for analyzing the drivers and barriers behind teachers' behavioral intentions towards AI tools presented as Figure 2 (UTAUT Model).

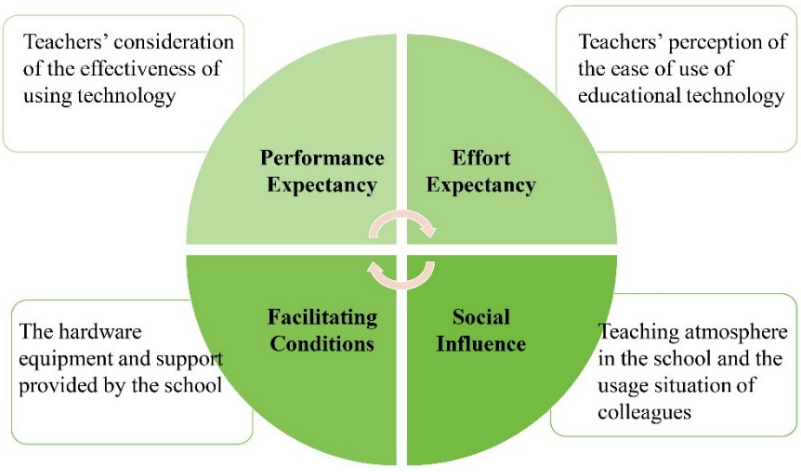

Figure 2. UTAUT Model.

Moving from intention to effective practice requires a specific knowledge base. The traditional TPACK framework has been criticized for its instrumental focus in the age of generative AI (Wu & Wu, 2025). Therefore, this study adopts the GHEX-IPACK framework presented as Figure 3. GHEX-IPACK framework., which expands upon TPACK by integrating critical dimensions of Goal-oriented, Human-centered, and Ethical knowledge alongside contextual awareness (Wu & Wu, 2025). This framework elucidates how teachers can structure their professional knowledge to design and orchestrate meaningful human-AI collaboration

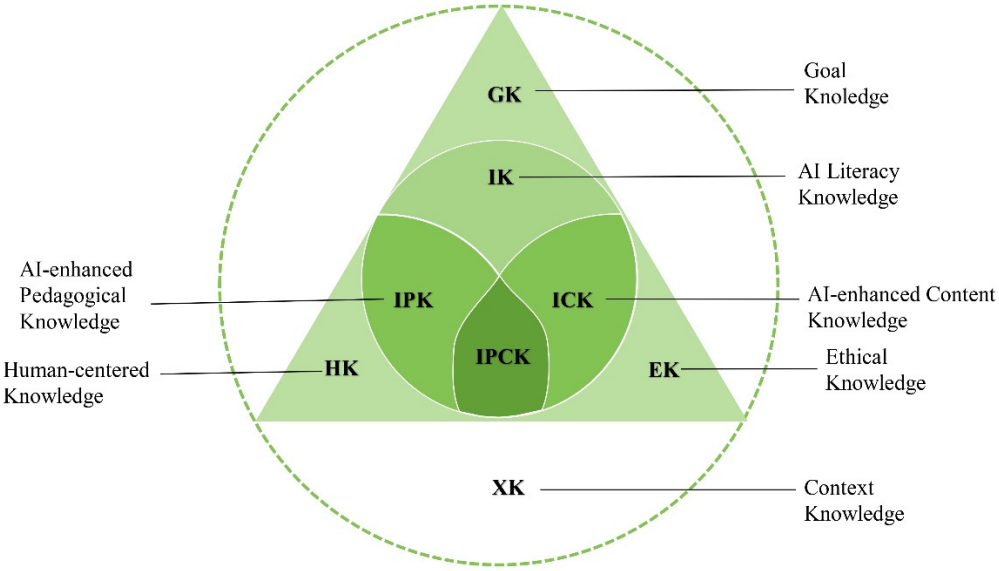

Figure 3. GHEX-IPACK framework.

2.2. Evolution of AI and Identified Research Gaps

The role of AI in language education is undergoing a paradigm shift, moving from instrumental use towards collaborative creation and co-evolution (Li et al., 2025). This evolution highlights the transformation of the teacher-AI relationship from "control-controlled" to "dialogue-co-creation" (Luo at al., 2025). However, a significant disconnect persists between macro-level theoretical advancements and micro-level classroom realities, revealing two critical gaps.

First, an implementation gap exists, as the process through which teachers translate AI capabilities into specific, executable teaching strategies remains underexplored. Second, an adaptation gap is evident, as generic frameworks often fail to align with the distinct instrumental, humanistic, and communicative goals of secondary school English education. Therefore, this study investigates the specific strategies teachers employ for human-AI collaboration, their dynamic evolution in practice, and the challenges encountered during implementation.

3. Research Design

3.1. Research Content and Questions

To delineate the specific application forms of human-AI collaborative strategies within the teaching process, Research Question 1 focuses on: How do secondary school English teachers apply human-AI collaborative strategies in practice across the stages of lesson preparation, classroom implementation, and learning assessment? Which levels of the SAMR model do these applications correspond to?

To analyze the motivations and considerations behind teachers' adoption behaviors, Research Question 2 aims to explore: Which core UTAUT factors significantly influence the depth and sustainability of teachers' adoption of the human-AI collaboration model? From the teachers' perspective, what are the specific advantages and limitations of this model?

To construct a future-oriented path for teacher development, Research Question 3 addresses the evolution of teachers' knowledge structures: What specific needs do secondary school English teachers face regarding the integration of content, pedagogical, and technological knowledge to effectively implement human-AI collaborative teaching? How should their GHEX-IPACK structure evolve to adapt to this new teaching model?

3.2. Research Participants

Five secondary school English teachers from Jiangxi Province participated, representing a spectrum of technology adoption attitudes and experiences. The group included both novice and veteran teachers (2 to 25 years of experience) from urban and rural regions, encompassing roles such as active explorers, cautious integrators, innovation leaders, and those adhering to more traditional methods. This diversity ensured a multifaceted perspective on human-AI collaboration.

3.3. Research Methods

This study employed semi-structured interviews as the primary method to gain an in-depth understanding of teachers' experiences. Interviews, averaging 25 min, covered teachers' backgrounds, specific AI use cases across teaching stages, and their perceptions of challenges and support needs. The collected data were transcribed and analyzed using thematic analysis to identify key patterns and insights related to the research questions.

4. Finding and Analysis

4.1. Application of AI Tools and SAMR Integration Levels in Human-AI Collaborative English Teaching

Through in-depth interviews and systematic coding of five secondary school English teachers, this study finds that AI tools have been deeply embedded throughout the core teaching processes: lesson preparation, instruction, and assessment. However, the level of technological integration is not uniform; it presents a continuous spectrum from superficial substitution to deep redefinition, clearly mapping onto the four levels of the SAMR model and revealing the stratified nature of human-AI collaborative strategies in practice presented as Figure 4. Human-AI Collaborative Teaching Workflow.

During the lesson preparation stage, integration extends beyond basic tool substitution. At the Substitution level, teachers commonly use AI assistants for "Intelligent Framework Generation", rapidly structuring lesson plans to enhance efficiency in foundational tasks. Progressing to the Augmentation level, AI enables "Preparation Efficiency and Expansion," such as automatically recommending multimedia resources, thereby enriching the breadth and diversity of teaching materials. More transformative practices emerge at the "Modification" level, where some teachers engage in "Dynamic Resource Creation," like producing short explanatory videos, signifying a redesign of the core outputs of preparation. Although the highest level, Redefinition, is on the horizon—exemplified by individual teachers experimenting with data-driven "School-Based Resource Library Development" to fundamentally alter collaborative preparation and knowledge accumulation—such practices remain nascent and far from routine application.

Within the instructional process, the variation in integration levels is most pronounced. Substitution is evident in "Mediatized Presentation," where digital slides replace traditional blackboard writing. Augmentation occurs through "Interactive Practice" (e.g., AI-empowered immediate pronunciation feedback), significantly increasing the frequency of classroom interaction and individual attention. Deeper integration happens at the Modification level, involving "Process Restructuring and Scenario Creation," such as embedding AI grammar checkers into the writing process, thereby transforming the traditional teacher-led, student-practice model. As for Redefinition, while teachers express a vision for AI-enabled "Personalized Learning Paths" where instruction adapts in real-time based on student data, current implementations are largely tentative and have yet to trigger a fundamental shift in the teaching paradigm.

Regarding teaching assessment, AI applications are driving a shift from summative evaluation towards formative, ongoing diagnosis. Substitution manifests as "Automated Grading," partially relieving teachers from the burden of manual marking. Augmentation appears as "Data-Driven Reporting," where AI-generated visual analytics make assessment feedback faster and more intuitive. A crucial Modification involves establishing a "Dual-Track Assessment System" combining initial AI evaluation with subsequent teacher review. This not only restructures the assessment workflow but also allows teachers to focus their expertise on providing higher-order cognitive and affective feedback that machines cannot offer. The Redefinition level, aiming for "Continuous Diagnostics" through AI tracking of student learning trajectories to enable precise, dynamic intervention, remains largely aspirational due to high demands on technological infrastructure and teacher data literacy.

In summary, the integration of human-AI collaboration in secondary school English teaching demonstrates a clear, progressive trajectory from shallow to deep adoption. Current practices are relatively mature at the Substitution and Augmentation levels, while the Modification and Redefinition levels present significant potential and room for growth. Figure 4 visually summarizes this progressive integration pathway across the three teaching stages.

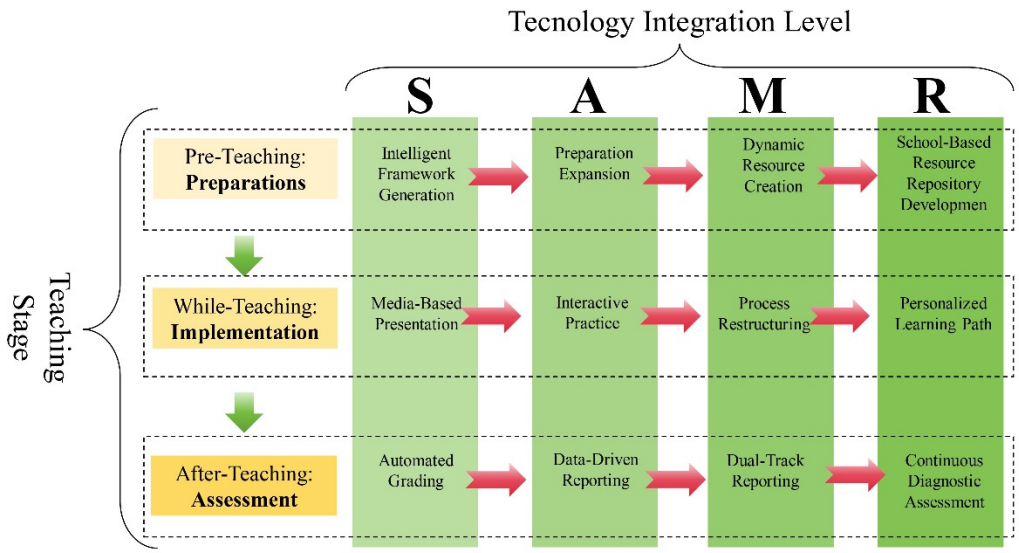

Figure 4. Human-AI Collaborative Teaching Workflow.

4.2. Teacher Adoption Motivations and Barriers: Analyzing the Capabilities and Limitations of the Human-AI Collaboration Model through a UTAUT Model

Grounded in the Unified Theory of Acceptance and Use of Technology framework, this study systematically analyzes the driving factors and primary concerns influencing teachers' adoption of the human-AI collaborative teaching model, thereby delineating its inherent advantages and practical challenges within the current educational context.

Analysis indicates that the model's strengths are rooted in its effective response to teachers' core performance expectations and usability needs, constituting the internal drivers for its adoption.

Teachers widely recognize the value of AI in enhancing teaching effectiveness, with Performance Expectancy functioning as a key driver of teaching efficacy. Features such as automated grading and personalized resource delivery not only significantly improve teaching efficiency but also enable personalized instruction that was previously difficult to scale. Additionally, these functionalities diversify teaching methods, directly addressing the core objective of optimizing teaching outcomes.

The model's notable convenience has garnered a favorable reception, as Effort Expectancy operates to lower usage barriers. User-friendly interfaces and efficient resource access mechanisms reduce technical thresholds, while the automation of mechanical tasks-including lesson preparation and grading-relieves teachers of routine burdens. This allows educators to redirect their focus toward more creative instructional design and meaningful student interaction, thereby generating strong incentives for adoption.

Social Influence and Facilitating Conditions collectively contribute to the formation of a nascent support environment. Widespread adoption among younger teachers, institutional requirements for educational informatization, and the demonstrative effects of lead teachers together create both peer pressure and institutional motivation for uptake. Moreover, the provision of smart classroom facilities and official training programs in some schools establishes the necessary material and knowledge foundations for initial implementation.

Conversely, the study also reveals multiple challenges hindering the model's deeper application, which directly constrain teachers' willingness to adopt and the depth of their practice.

As for Performance Expectancy, teachers point out discrepancies in AI's integration with education. Platform data can be inaccurate, and machine feedback lacks emotional warmth and humanized insight, especially when dealing with complex knowledge or situations requiring improvisation, where AI cannot replace teachers' professional judgment and core role, highlighting current limitations in AI's understanding of educational complexity.

In other ways, Effort Expectancy also challenged the human-AI pattern by the hidden costs. The adaptive and learning costs associated with technology pose practical obstacles. Some AI products clash with teachers established pedagogical approaches, requiring them to adjust their teaching to fit the technology rather than having the technology serve their pedagogy. Additionally, technical glitches disrupt instructional flow and the time investment needed to learn new tools increase the usage burden, partially offsetting the perceived benefits.

Besides the internal influences, Social Influence and Facilitating Conditions as external environmental causes highlight support deficiencies. Imbalances in external support are a prominent shortcoming that arouses teachers' attention. Macroscopically, the urban-rural hardware divide exacerbates educational inequality, with inadequate

facilities in rural schools posing a significant objective barrier. Microscopically, individual teachers face a lack of systematic training and insufficient time for exploration due to heavy teaching loads. Moreover, anxiety about potential technological displacement and resistance from traditional educational beliefs invisibly slows the acceptance process.

In conclusion, viewed through the UTAUT lens, the current human-AI collaborative teaching model presents a landscape of coexisting opportunities and challenges. Its advantages lie in precisely addressing teachers' dual expectations of "teaching efficacy" and "workload reduction," demonstrating significant application potential. Its limitations, however, reveal the chasm that must be crossed to move from "instrumental use" to "ecosystem integration." Crossing this chasm depends not only on more precise and human-centered technological iteration but also on the construction of a systemic support environment to address deeper issues of technological reliability, human-AI collaboration paradigms, and educational resource equity. Figure 5. Human-AI Collaboration from the Perspective of Teachers. synthesizes these key influencing factors identified through the UTAUT analysis.

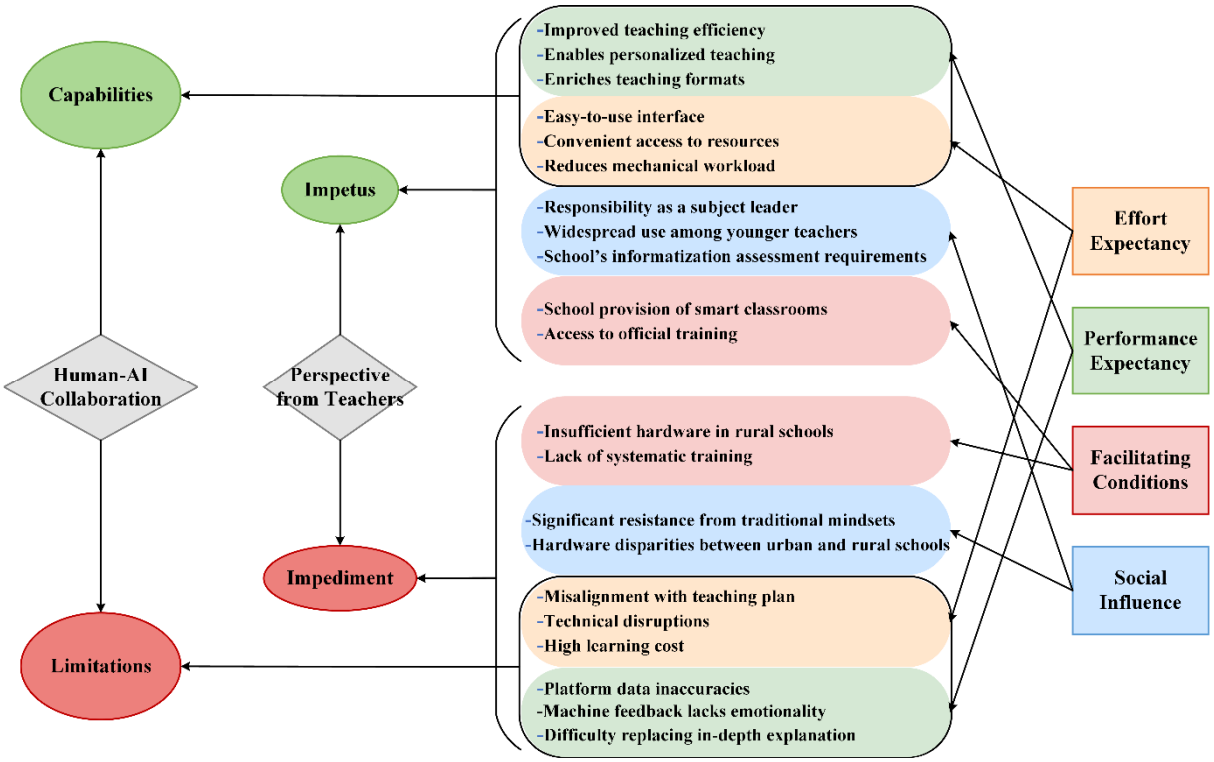

Figure 5. Human-AI Collaboration from the Perspective of Teachers.

4.3. A New Paradigm for Human-AI Collaboration in Secondary School English Teaching: Based on GHEX-IPACK Theory Framework

Building upon the analysis of technology integration levels (SAMR model) and adoption motivations (UTAUT theory), this study introduces the comprehensive GHEX-IPACK framework to construct a new paradigm for Human-AI collaboration in secondary school English teaching. This paradigm addresses the core question of what knowledge structure teachers need to effectively orchestrate Human-AI collaboration and achieve fundamental educational goals in the GenAI era. It consists of three dynamically interconnected components: the Driving Engine, the Core Skeleton, and the Practice Cycle.

The Driving Engine comprises the internal and external factors identified by the UTAUT model. Teachers' Performance Expectancy (e.g., the desire to enhance teaching efficiency and enable personalized instruction) acts as the primary internal force pulling their practice towards higher SAMR levels (e.g., from Substitution to Redefinition). Conversely, Effort Expectancy (e.g., perceived ease of use and reduced mechanical workload) serves as the foundational threshold, determining initial adoption and providing cognitive space for developing more complex knowledge. These internal drives are simultaneously catalyzed or constrained by Social Influences (e.g., peer pressure and institutional requirements) and Facilitating Conditions (e.g., resource availability and training), which form the critical external environment.

Driven by this engine, the teacher's knowledge system undergoes systematic reconstruction, forming the Core Skeleton of the paradigm the GHEX-IPACK knowledge system. This skeleton evolves through four progressive layers, presented in Table 1 Simplified GHEX-IPACK-SAMR Mapping.

Table 1. Simplified GHEX-IPACK-SAMR Mapping.

Knowledge Layer	Core Components	Corresponding SAMR Stages	Core Function
Foundation Layer	IK IPK	Substitution, Augmentation	Supports basic tech integration
Integration Layer	EK XK	Modification	Underpins moderate tech integration
Core Layer	IPCK HK	Redefinition	Enables in-depth Human-AI collaboration

Guided by this core skeleton, teaching practice evolves through the Practice Cycle, manifested as a spiral progression along the SAMR model across lesson preparation, implementation, and assessment. Each successful ascent to a higher SAMR level represents a dynamic iteration where motivation drives practice, practice validates and enhances motivation; knowledge guides practice, and practice refines knowledge.

In conclusion, this paradigm systematically illustrates that effective Human-AI collaboration in English teaching is a complex, dynamic, and iterative process. It is driven by teacher motivation within a specific environment, orchestrated through a sophisticated and evolving knowledge system (GHEX-IPACK), and ultimately realized and refined through cyclical teaching practice (SAMR). This framework provides a comprehensive theoretical map and practical pathway for empowering teachers to transition from being passive users of technology to becoming proactive designers of human-AI intelligence and steadfast guardians of educational values. This integrated framework is visually represented in the conceptual model presented in Figure 6 (A New Paradigm of Human-Machine Collaboration).

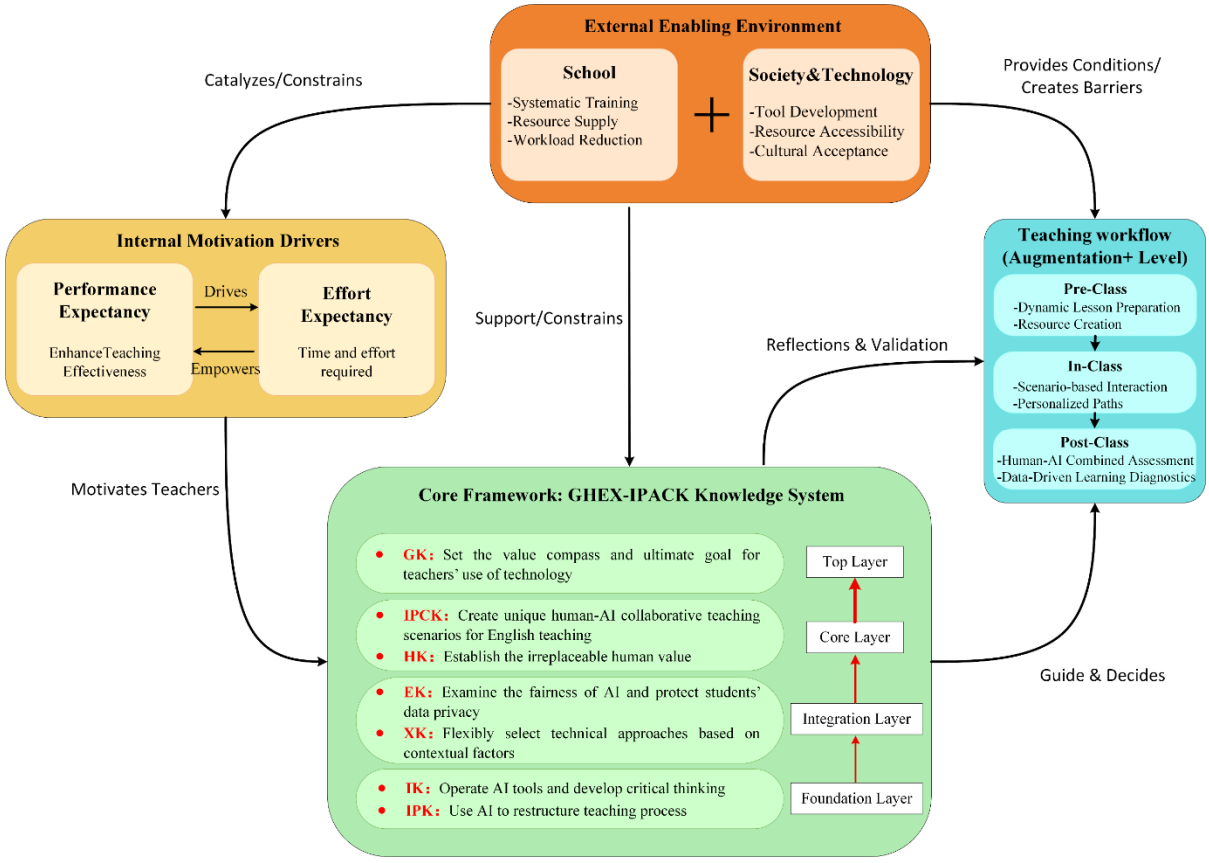

Figure 6. A New Paradigm of Human-Machine Collaboration.

5. Discussion

This study situates its findings within broader theoretical perspectives to clarify its contributions. The data confirm the SAMR model's progression but reveal a "mid-level blockage" at the Modification and Redefinition stages, highlighting that integration depth is constrained by socio-technical ecosystem factors like institutional

resistance (Ma et al., 2025), not just technological availability. This finding moves beyond mere classification to underscore the need for targeted support to overcome implementation barriers.

The analysis of teachers' knowledge structures empirically supports and extends the GHEX-IPACK framework. Findings show that teachers evolving into "innovative collaborators" (Luo et al., 2025) dynamically integrate knowledge to solve the core problem of making AI serve English teaching. This process, where Human-centered (HK) and Goal-oriented (GK) knowledge act as critical pathways for role transition, provides subject-specific validation for GHEX-IPACK as a necessary evolution from TPACK in the AI era (Wu & Wu, 2025).

From a UTAUT perspective, the study refines the understanding of adoption dynamics. Effort Expectancy and Performance Expectancy function as a "push-pull" system that drives practice progression, while Social Influence and Facilitating Conditions are critical for overcoming the mid-level blockage. This suggests that in educational contexts, UTAUT variables interact dynamically rather than exerting static, isolated effects (Venkatesh et al., 2003).

The core theoretical contribution is the synergistic integration of SAMR, UTAUT, and GHEX-IPACK into a cohesive framework addressing what AI can do, why teachers adopt it, and how they can use it effectively. This addresses the identified research gaps by modeling the teacher as the "central decision-maker" in the "teacher-AI-student" interaction. Practically, it calls for teacher training focused on HK and GK, systemic support from administrators, and more pedagogy-aligned tools from developers.

6. Conclusions

This study finds that while Human-AI collaboration is reshaping secondary English instruction, its integration remains superficial—limited mostly to Substitution and Augmentation. Truly transformative practices at the Modification and Redefinition levels are still rare, hindered by technological barriers and insufficient systemic support. Performance Expectancy and Effort Expectancy primarily motivate teacher adoption. To deepen integration, teacher development should focus on fostering a dynamic GHEX-IPCK knowledge framework, enabling educators to act as strategic "co-pilots" with AI rather than passive tool users. This requires not only pedagogical training, but also institutional backing and technology designed around real teaching contexts. Several limitations should be noted, including a small sample of teachers from one province. Future studies could expand in scope, adopt mixed methods, and incorporate student perspectives to better understand learning outcomes and emotional impacts. The rise of Generative AI also calls for further research into its influence on teacher roles, curriculum design, and educational ethics.

Ultimately, advancing Human-AI collaboration represents an ecological evolutional mutual adaptation between technological and educational logics. The goal is not to replace teachers, but to build a cooperative paradigm centered on teacher agency, where AI and human wisdom jointly foster future-ready talents.

Author Contributions

S.Y.: Writing—original draft, Methodology, Investigation, Formal analysis, Conceptualization. B.S.: Supervision, Funding acquisition, Conceptualization, Writing—review & editing. X.Y.: Supervision, Conceptualization, Writing—review & editing. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Informed consent was obtained from all subjects involved in the study.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The datasets generated and/or analyzed during the current study are not publicly available due to ethical restrictions—specifically, to protect the privacy and confidentiality of participants, as agreed upon in the informed consent process. But datasets are available from the corresponding author on reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest with respect to the research, authorship, and/or publication of this article.

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