Synergistic Empowerment of Curriculum Graphs and Intelligent Agents in College English Smart Courses Construction

Guohui Rao

School of Foreign Languages, Chengdu University of Information Technology, Chengdu, 610225, China
27508074@qq.com

Abstract. The rapid evolution of generative artificial intelligence is driving higher education toward a profound digital and intelligent transformation. As a compulsory foundational course for all undergraduate students, College English and its smart courses play a crucial role in implementing the national education digitalization strategy and enhancing the quality of foreign language talent cultivation. Currently, AI applications in college foreign language teaching are largely tool-oriented and fragmented. The curriculum knowledge system and intelligent interactive technologies have not been deeply integrated, which hinders the full-process, systematic implementation of smart education. Grounded in the pedagogical characteristics and practical challenges of College English courses, this paper takes the synergistic integration of curriculum graphs and pedagogical intelligent agents as the core approach. It systematically analyzes their functional complementarity and internal synergy mechanisms, constructs a three-dimensional curriculum graph covering knowledge, problem, and competence dimensions, designs a multi-role pedagogical intelligent agent matrix that serves teaching, learning, assessment, and administration, and proposes a four-layer collaborative operation architecture comprising graph layer, data layer, agent layer, and application layer. The proposed College English smart courses construction framework, empowered by the synergy of curriculum graphs and intelligent agents, opens a new path for the digital teaching reform of public foreign language courses and offers references for advancing the digital and intelligent transformation of foreign language education in higher education institutions.

Keywords: Curriculum Graph, Intelligent Agent, College English, Smart Courses

1 Introduction

In recent years, the iterative upgrading of generative AI has shifted the role of intelligent technologies from auxiliary teaching tools to a core force reshaping the educational ecology. Universities are actively integrating generative AI into their curricula and pedagogical strategies, recognizing its transformative potential to enhance educa-

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tional outcomes, foster critical thinking, and prepare students for future careers [1]. The Chinese national policy explicitly calls for using artificial intelligence to empower the development of smart education systems and promote the intelligent upgrading of curriculum and teaching systems, pointing out the policy direction for teaching reform in higher education. As a public foundational course for all undergraduates, College English serves as the core vehicle for cultivating students' language proficiency, intercultural communication competence, and global vision. In the digital and intelligent era, it faces both important opportunities for transformation and upgrading and profound challenges from traditional teaching models.

At present, explorations of AI-empowered College English teaching have been gradually carried out, but most practices remain at the level of fragmented application of individual technical tools. AI tools are used for speaking, reading, and writing practice or testing, without forming a systematic framework of deep integration between technology and curriculum. A smart course is a student-centered intelligent teaching system that integrates advanced information technology and educational concepts. Its core features include intelligent learning environments, digital resources, personalized learning processes, diversified assessment, and intelligent teacher-student interaction. Developing smart College English curricula is a vital initiative to adapt to educational development trends in the information age and address contemporary challenges [2]. Driven by AI technology, smart courses construction has become an inevitable choice for improving teaching quality and cultivating high-quality foreign language talents. Integrating curriculum graphs and pedagogical intelligent agents to jointly empower College English smart courses, in line with the teaching reality of public College English courses, represents a new pathway for exploring digital teaching reform of foreign language education in universities.

2 Practical Challenges of Traditional College English Teaching

2.1 Low Degree of Personalized Instructional Adaptation

As a public foundational course for all undergraduates, College English enrolls students with diverse backgrounds, marked by significant disparities in English proficiency, learning ability, and developmental goals. Constrained by limited class hours and teacher workload, traditional classroom teaching mostly adopts a standardized approach with uniform pace and content. It is difficult for teachers to cater to the learning rhythms and ability gaps of students at different levels. Differentiated instruction often remains at a rough division of fast-track and slow-track classes, or stays at the conceptual level, failing to be implemented in daily teaching sessions. As a result, students with weak foundations struggle to keep up with the teaching pace, while advanced students lack sufficient room for growth. The educational philosophy of personalized instruction can hardly be put into real practice.

2.2 Fragmented Knowledge Structure and Imbalanced Language Output

Traditional College English teaching develops linearly based on textbook units, with vocabulary, grammar, passages, and other language points presented in isolation and lacking deep logical connections. This easily leads to scattered "knowledge islands". Students' learning often stays at the level of rote memorization of individual language points, making it difficult to build a systematic framework of language cognition. Meanwhile, teaching generally shows a structural tendency of emphasis on language input and neglect of output. Input-oriented content, such as vocabulary, grammar explanations and text reading analysis, takes up the vast majority of class time, while output-oriented practice, such as oral expression, writing training, and communicative interaction, accounts for a small proportion. Students have very limited opportunities for in-class language practice. After class, students generally *lack* authentic language communication scenarios and professional, real-time feedback channels, so output skill training often becomes a formality, with errors left uncorrected in a timely manner.

The combination of these two factors directly results in students' generally weak ability to integrate knowledge and transfer it across scenarios. To some extent, this causes the phenomena of "mute English" and "high scores but low competence", which deviate from the training goal of comprehensive language application ability.

2.3 Scattered Application of Technologies

With the development of educational digitalization, various online learning platforms and AI teaching tools have gradually entered College English classrooms, but most applications remain scattered and fragmented. Existing AI tools mostly serve a single teaching session—for example, using AI for writing correction, oral reading practice, or assigning homework and pushing learning resources via platforms, without deep integration with the curriculum's knowledge system and teaching processes. There is a disconnection between technical tools, curriculum content, and instructional design.

Moreover, data across different tools are isolated from each other. Data generated during teaching, such as learning behaviors and competence assessment results, cannot be jointly analyzed, making it unable to support a closed instructional loop from learning diagnosis, content delivery, and process guidance to effect evaluation. The deep empowerment of technology for teaching has not been fully unleashed, and in some situations, the dispersion of tools increases the operational burden on teachers and students instead.

2.4 Insufficient Effectiveness of Process Assessment

For a long time, the traditional assessment system for college English courses has been predominantly summative in nature, with evaluation content focusing heavily on knowledge-based aspects like vocabulary, grammar, and reading comprehension, while insufficient attention has been paid to assessing students' comprehensive com-

petencies, including oral expression, cross-cultural communication, and critical thinking. Moreover, formative assessments have largely been confined to superficial data such as attendance, homework completion, online video viewing duration, and chapter quiz scores, failing to delve deeply into students' learning processes, cognitive development, and trajectories of competency growth. However, such learning behavior data accumulated during the teaching process as students' knowledge-access paths, interaction records with intelligent tools, and participation in group collaborations, have not yet been systematically mined and analyzed. This neither provides teachers with refined insights into learning conditions for dynamic teaching optimization, nor enables timely early warning and personalized intervention for students' learning difficulties. The diagnostic, feedback, and guiding functions of assessment have not been fully fulfilled.

These common problems in College English courses have found better solutions in the era of generative AI. Powered by big data and deep learning, AI can realize adaptive content recommendation, personalized feedback, and intelligent teaching assistance, injecting new vitality into College English teaching. It promotes the transformation of teaching models from traditional to intelligent, so as to better meet the demand for talent cultivation in the new era [3].

3 Core Advantages and Complementary Logic of Curriculum Graphs and Pedagogical Intelligent Agents

3.1 Pedagogical Advantages of Curriculum Graphs

A curriculum graph is a structured knowledge representation tool. In a curriculum graph, course content is decomposed and systematically organized, where each "node" represents a specific curriculum knowledge point, and the "edge" connecting nodes accurately depicts the logical relationships between knowledge points, including causal, progressive, and parallel relationships [4]. With its structured knowledge representation logic of nodes and relationships, the curriculum graph can organize scattered linguistic elements (vocabulary, grammar, discourse, etc.) into a logically coherent network that clearly outlines their interconnections. It guides students to move beyond rote memorization of isolated language points and build a systematic cognitive framework of language, thereby fundamentally addressing the long-standing problem of knowledge fragmentation in traditional teaching methods.

Based on clearly defined knowledge nodes, multimodal teaching resources such as audio-visual materials, extended reading texts, and supporting exercises can be precisely bound to corresponding knowledge points. It forms an integrated resource matrix of "knowledge point—learning resource—assessment question." This not only significantly enhances the efficiency of teaching resource utilization but also ensures a highly precise match between learning content and students' needs. Meanwhile, the visually presented network of knowledge associations provides students with a clear roadmap for self-directed learning. Students with weaker English foundations can trace back along the knowledge pathways to fill in gaps in prerequisite content, while

advanced students can explore related nodes to extend and deepen their learning. This provides a solid underlying support for layered and personalized learning design.

For College English courses, the curriculum graph can cover all five skill dimensions —listening, speaking, reading, writing, and translation, integrate multi-level knowledge nodes of vocabulary, grammar, discourse, pragmatics, and culture. It also connects to a variety of teaching resources, including audio and video materials, exercises, and supplementary readings, enabling visualized presentation of knowledge, associative retrieval, and personalized navigation.

3.2 Pedagogical Advantages of Pedagogical Intelligent Agents

According to scholar Michael Wooldridge, the term "agent" refers to a hardware or (more commonly) software-based computer system with the following properties: autonomy, social ability, reactivity, and pro-activeness [5]. Pedagogical agents, also called teaching agents, are autonomous entities that inhabit learning environments and engage learners in rich, face-to-face interactions [6]. In today's era of generative AI, pedagogical intelligent agents are intelligent teaching systems built on large generative language models, with autonomous interaction and adaptive capabilities. They can perform multiple roles and functions in teaching activities, serving as the core carrier for human-machine collaborative teaching.

Powered by generative AI, pedagogical intelligent agents provide full-scenario intelligent support for College English teaching with their autonomous interaction and adaptive learning capabilities. They can simulate authentic language communication scenarios and undertake diverse learning tasks, such as speaking practice, writing guidance, and discourse analysis, through conversational interaction. This creates a round-the-clock language output training environment for students, which can effectively fill the gap of insufficient speaking practice time and limited scenarios in traditional classroom teaching.

In response to the strong demand for real-time feedback in language learning, intelligent agents can provide instant feedback on various learning outputs, including oral expression, written responses, and exercise practice. They give feedback from multiple dimensions, for example, linguistic accuracy, appropriateness of expression, and logical coherence, enabling the "learning–practice–assessment–revision" cycle to be completed synchronously. This significantly shortens the learning feedback cycle and improves learning efficiency per unit time. Furthermore, intelligent agents can continuously track students' learning behavior data and their progress in skill development, dynamically adjust content difficulty and interaction pace, and tailor personalized learning plans for students with different levels of proficiency and diverse learning styles. This turns personalized instruction from a conceptual idea into daily learning processes.

3.3 Inherent Complementarity of Their Synergistic Empowerment

The synergy between curriculum graphs and pedagogical intelligent agents is not a simple superposition of functions, but a deep integration of a "static knowledge base" and a "dynamic interaction engine". The two are inherently complementary.

On the one hand, curriculum graphs provide a standardized disciplinary knowledge framework for pedagogical intelligent agents. Although generative agents have strong interaction capabilities, they are prone to blurred knowledge boundaries and content deviation. Curriculum graphs anchor the knowledge system and content boundaries of College English, providing accurate knowledge references for agents' interactive outputs. This effectively reduces AI hallucinations and ensures the systematicity and accuracy of teaching content. On the other hand, pedagogical intelligent agents endow curriculum graphs with dynamic interaction capabilities. Traditional curriculum graphs are essentially static knowledge networks, where students mostly engage in passive browsing. Intelligent agents, however, can dynamically access knowledge points and resources from the graph based on students' learning behaviors and competence profiles, and proactively recommend tailored learning paths and content. They transform static knowledge networks into dynamic learning support systems that are conversational, adaptable, and iterative.

Through coordinated interaction, the two address both the lack of interactivity in graphs and the weak systematic knowledge base of standalone agents. Together, they support the entire process of knowledge construction, teaching implementation, and learning assessment for smart courses, driving the shift of smart courses development from resource-supply oriented to intelligent-adaptation oriented.

4 Construction of College English Smart Courses System Empowered by Curriculum Graph-Intelligent Agent Synergy

Aligned with College English teaching objectives and students' competence development needs, the traditional linear knowledge structure arranged by textbook chapters is shattered, and instead multidimensional, hierarchical curriculum graphs that encompass knowledge, problems, and competency are constructed, so as to lay a solid knowledge foundation for the smart courses.

4.1 Constructing a Multi-Dimensional Curriculum Graph

Comprehensive Skill Knowledge Graph. Based on the national *College English Teaching Guide*, it systematically organizes the core knowledge points of the five skill modules (listening, speaking, reading, writing, translation) in textbooks, decomposes multi-level knowledge nodes including vocabulary, grammar, discourse, pragmatics, and culture, and clarifies the logical relationships between knowledge points (prerequisite, subsequent, parallel, progressive, etc.). At the same time, multi-modal resources like courseware, audio-visual materials, exercise sets, and extended reading are pre-

cisely associated with corresponding knowledge points, forming an integrated knowledge points, resources, and assessment network. This supports students in self-directed learning following the graph, and also provides support for teachers' systematic lesson preparation.

Scenario-Based Problem Graph. Driven by authentic language application scenarios, the problem graph covers daily communication, academic discussion, professional scenarios, and other diverse contexts. Typical language communication tasks are transformed into problem nodes, which are connected with the series of knowledge points and competence points required to solve the problem, forming a complete problem-solving path. This guides students to achieve mastery of language knowledge in the process of solving real-world problems.

Hierarchical Competence Graph. Focusing on the core competence training objectives of College English, the competence graph covers such abilities as basic language skills, comprehensive application, intercultural communication, and critical thinking. Competence indicators at each level are decomposed into observable and evaluable competence points, which are mapped to knowledge points in the knowledge graph and task scenarios in the problem graph. This clarifies the competence development goals corresponding to knowledge acquisition and problem solving, realizes traceability and evaluability from knowledge mastery to competence improvement, and promotes the shift of teaching from knowledge transmission to competence cultivation. Teaching practice has shown that the blended learning model driven by multiple graphs effectively solves the problem of students' fragmented knowledge systems, and realizes dynamic diagnosis of learning conditions and precise delivery of personalized learning paths [7].

4.2 Building a Multi-Role Collaborative Pedagogical Intelligent Agent Matrix

To meet the full-process needs of College English teaching, a multi-role intelligent agent matrix with complementary functions and coordinated operation is built. It spans from teaching and learning to assessment and administration, providing an intelligent interaction engine for smart courses.

Intelligent Teaching Assistant for Teachers. Tailored to teaching needs, it performs functions such as lesson preparation assistance, resource generation, teaching process design, and learning condition analysis. It can quickly generate lesson plans, courseware, and teaching materials based on the curriculum graph, and customize multi-modal teaching resources according to teaching themes, so as to improve lesson preparation efficiency and teaching pertinence. It can assist in designing classroom activities, differentiated homework, and assessment questions, and undertake repetitive tasks such as Q&A and grading, allowing teachers to devote more energy to instructional design and in-depth interaction. In addition, it can automatically collect and analyze students' learning behavior data, generate learning condition analysis reports, and identify common difficulties and individual weaknesses.

Intelligent Learning Companion for Students. For students' learning needs, it provides round-the-clock language learning support and comprises modules such as Q&A, skill training, learning planning, and feedback guidance. It features 24-hour question-answering, immediate responses to knowledge-based queries on vocabulary, grammar, and text comprehension. It can carry out specialized practice such as immersive oral dialogue, writing correction and polishing, and intensive listening training. It can also customize personalized learning plans and phased improvement plans based on learner profiles and the curriculum graph, guiding students to map out their learning paths. Furthermore, it conducts multi-dimensional evaluation of students' practice outcomes and provides targeted improvement suggestions. Therefore, it renders full-process assistance in learning, practice, assessment, and revision.

Intelligent Assessor for Administration. For teaching assessment and management, it undertakes process data collection, learning effectiveness evaluation, and teaching quality diagnosis. It automatically collects students' full-process learning behavior data and learning outcome diagnoses, and dynamically assesses knowledge mastery and development of competence in combination with graph-based feedback. It generates comprehensive class-level learning reports and individual learning profiles, conducts quantitative analysis of overall teaching effectiveness, identifies weak points in teaching sessions, and provides data support for teaching optimization. Moreover, it automatically provides early warning for students with learning difficulties, assisting teachers in carrying out precise intervention. By integrating data and analytical diagnosis, it serves teaching management and quality feedback for teachers and schools.

4.3 Establishing a Four-Layer Collaborative Operation Architecture

To achieve deep synergy between curriculum graphs and intelligent agents, a four-layer underlying operation architecture of graph layer–data layer–agent layer– application layer is constructed to ensure the stable operation, connection, and upgrading of the smart courses.

The graph layer serves as the knowledge base, which stores structured three-dimensional curriculum graphs and associated teaching resources, providing a content baseline for all intelligent interactions. The data layer continuously aggregates multi-dimensional data, such as students' learning behaviors, assessment results, and interaction records, to dynamically update learner profiles, rendering data assistance to personalized services of intelligent agents. The intelligent agent layer leverages the knowledge resources from the graph layer and the user profiles from the data layer to perform various teaching interaction tasks, for example, lesson preparation, question answering, practice, and evaluation. The application layer acts as the external service interface, offering tailored teaching function interfaces for teachers and students respectively.

The four-layer architecture realizes dynamic optimization through data flow: learner behavior data provides a practical basis for resource optimization of the curriculum graph and algorithm iteration of intelligent agents, while knowledge updating of the

curriculum graph in turn supports the capability improvement of intelligent agents. The two synergistically drive the continuous development and improvement of the smart courses.

5 Conclusion

College English Smart courses construction plays an important role in building the higher education system and cultivating talents for the new era, and has become a key breakthrough point and a new quality productive force for promoting high-quality educational development [8]. The synergistic empowerment of curriculum graphs and intelligent agents provides a systematic and implementable construction plan for College English smart courses in the digital and intelligent era. With complementary advantages and deep integration, the two can not only address common problems in traditional teaching, such as knowledge fragmentation, insufficient personalization, imbalance between language input and output, and single-dimensional assessment, but also promote the shift of College English teaching from teacher-centered to student-centered, and from large-scale standardized teaching to layered individualized cultivation. This collaborative model can effectively support students' personalized learning, improve their comprehensive language application ability and information literacy, and help teachers enhance their digital teaching competence. It also enables teachers to invest more energy in curriculum design and value guidance, thus achieving a dual improvement in teaching efficiency and overall competence.

However, it is also important to recognize that College English smart course construction is a long-term process of continuous iteration and optimization. Since current research is still in the preliminary construction and practice stage, its teaching effectiveness and adaptability for large-scale promotion remain to be verified. In future practice, the synergy mechanism between curriculum graphs and intelligent agents should be refined, and the ethical norms of AI-driven teaching should be strengthened, so as to make the human-machine collaborative smart teaching model more mature and complete, and truly serve the cultivation of versatile talents with global vision and cross-cultural communication competence in the new era.

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References

1. Jin, Y., Yan, L., Echeverna, V., Gaševic, D., & Martinez-Maldonado, R. (2025). Generative AI in higher education: A global perspective of institutional adoption policies and guidelines. Computers and Education: Artificial Intelligence, 8. https://doi.org/10.1016/j.caeai.2024.100348
2. Wang, H. (2025). “Using AI to Use AI”:An Innovative Practice for Building Smart College English Courses Foreign Language and Literature, 41(6), 28–40. https://doi.org/10.26922/j.cnki.waiguoyuwen.2025.06.001
3. Wang, H. (2026). Exploring AI-empowered College English teaching based on the human-centered concept. Foreign Languages in China, 23(1), 60–68. https://doi.org/10.13564/j.cnki.issn.1672-9382.2026.01.001
4. Shen, H., Gong, H., & Fu, H. (2025). Smart Courses Construction: Innovative Transformation Paths from Digital Empowerment to Teaching Models. China University Teaching, (9), 10–17+2. http://kns-cnki-net-s.webvpn.cuit.edu.cn:8118/kcms2/article/abstract?v=2g3PLS-OwFr5NEy-aOflozB9pWm5q8sY2wD2cr2hVkaeSK6-Li2qQxytDLAxBH8v4C7eGpJBUp_FWrPQS0kg4jvae_HX1XfH_WYatWJtJlxXR6b_dbNmf7wpZhr47mQGWYlFvW5fTlXj6fXnVMa9DiXkqG-IA2HQi2ZAa5DtUu9POr67fTIKt8g==&uniplatform=NZKPT&language=CHS
5. Wooldridge, M., & Jennings, N. R. (1995). Intelligent Agents: Theory and Practice. The Knowledge Engineering Review, 10(2), 115–152. https://doi.org/10.1017/S0269888900008122
6. Johnson, W. L., & Lester, J. C. (2018). Pedagogical agents: Back to the future. AI Magazine, 39(2), 33–44. https://doi.org/10.1609/aimag.v39i2.2793
7. Li, W., Li, J., Zhao, Y., & Shi, X. (2026). Research on multi-graph driven reform of inertial navigation smart course. Bulletin of Surveying and Mapping, (S2), 392–395. https://doi.org/10.1347/j.cnki.11-2246. 2026.S275
8. Zhao, W., & Chen, W. (2025). AI-enhanced College English curriculum construction oriented toward the “Four New Disciplinary Initiatives”. Foreign Language World, (5), 36–41. https://doi.org/10.26971/j.cnki.flw.1004-5112.2025.05.007

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