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Educational Intelligent Agents: Connotation, Classification, and Application in Foreign Language Teaching

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Abstract: *The rapid advancement of artificial intelligence technology is profoundly reshaping educational paradigms. As its tangible embodiment within the educational sphere, Educational Intelligent Agents (EIAs) exhibit significant application potential. This study systematically explores the core connotation and evolutionary logic of EIAs, proposing a three-dimensional classification framework integrating functional roles, modes of interaction, and technical mechanisms. It conducts an in-depth analysis of their unique value in enhancing the interactivity, personalization, and cultivation of cross-cultural communicative competence within foreign language teaching (FLT). Furthermore, the study investigates the application value and innovates models for EIAs in FLT contexts. This research contends that by creating "simulated-real-time-adaptive" linguistic environments, intelligent agents can effectively bridge the gap between traditional classrooms and authentic language use. Concurrently, the study directly addresses pertinent ethical challenges and technological bottlenecks, advocating for the establishment of a new intelligence-driven educational paradigm that prioritizes "human-machine collaboration guided by ethical principles". This proposed paradigm aims to foster the in-depth advancement and sustainable development of EIAs within FLT and the broader educational ecosystem.*

Keywords—educational intelligent agents; foreign language teaching; human-machine collaboration; personalized learning; digital transformation of education

1. INTRODUCTION

The deep integration of artificial intelligence (AI) and education is catalyzing structural transformations in educational paradigms (Wang & Li, 2026). Educational Agents (EAs), as concrete manifestations, are progressively restructuring the ecosystem of "teaching" and "learning" by simulating human instructors' cognitive capabilities and interactive behaviors. Propelled by the dual forces of surging global demand for digital learning and breakthroughs in generative AI technologies, EAs have transitioned from laboratory settings to scalable application scenarios (Wang et al., 2023). According to the Global Education Technology Report published by the International Society for Technology in Education (ISTE, 2023), 76 % of educational institutions in developed nations have deployed instructional agents, with their penetration in foreign language teaching exhibiting the most significant growth—surpassing figures from five years prior by 320%. This phenomenon signals a critical juncture of "the agentic turn" in pedagogy: educational actors are expanding from singular human teachers to collaborative "human-machine" entities, while pedagogical interactions evolve from linear transmission to multimodal dynamic responsiveness (Baker & Smith, 2019). Within this context, systematically deconstructing the theoretical foundations and practical pathways of EAs becomes a prerequisite for advancing the rational development of educational AI.

The theoretical construction of EAs urgently necessitates moving beyond the cognitive constraints of an instrumentalist view of technology. Current research reveals a dual fragmentation: on one hand, technical researchers prioritize agent architecture design yet overlook necessary adaptations to pedagogical ontology (Luckin et al., 2016); on the other hand, educational scholars focus on validating teaching efficacy while neglecting deep deconstruction of agents' behavioral models and cognitive logics. This schism results in superficial replication in practical applications: most systems remain confined to conversational queries or scripted interactions, failing to activate EAs' core value as "Cognitive Partners". Consequently, this study takes conceptual clarification as its logical starting point, reconstructing a framework through pedagogical, cognitive science, and human-computer interaction (HCI) lenses. It subsequently develops a multi-dimensional classification model integrating form and function to resolve the dilemma of "technological black-boxing", with specific emphasis on delineating functional divergences between Adaptive Agents (emphasizing dynamic adjustments based on learner modeling) and Social Agents (prioritizing social presence construction).

Foreign language teaching, as a prototypical high-interactivity domain, provides a natural proving ground for empirically testing educational agents. Traditional language classrooms confront three core contradictions: the tension between individual learner variability and standardized instruction; the dissonance between authentic communicative needs and environmental limitations; and the conflict between demand for immediate feedback and constrained teacher availability (Zhang & Lu, 2026). Leveraging three core capabilities—context generation, multimodal interaction, and

real-time assessment—agents demonstrate revolutionary potential in constructing immersive linguistic environments and facilitating micro-discourse strategy training (Sun et al., 2025). This study will critically examine at the applied dimension: (1) How can agent behavioral modeling reshape second language acquisition pathways? (2) How might agent-teachers and human instructors establish functionally complementary "mentor-apprentice system pairings"?

The research innovation lies in constructing an evaluation matrix for language learning agents—one that examines explicit metrics such as language proficiency gains alongside implicit competencies including communicative awareness and cultural empathy. This approach ultimately aims to foster deep synergy between pedagogical essence and technological innovation.

2. The Core Connotation and Evolutionary Logic of Educational Agents

2.1 Core Connotation of Educational Agents

Educational Agents (EAs), as products of the deep integration of educational technology and artificial intelligence, are defined as computational entities and pedagogical roles that integrate situational awareness, pedagogical decision-making, and natural interactivity (Liu et al., 2026). Functioning within specific educational contexts, they employ intelligent actions to advance students' cognitive and affective development. Distinct from traditional learning software, Educational Agents possess dual-dimensional characteristics of human-likeness and autonomy.

On the one hand, they leverage multimodal perception technologies to construct learner profiles, precisely discerning learners' cognitive development levels, learning state deviations, and emotional inclinations. This capability enables dynamic coordination within the human-machine-environment triad. On the other hand, relying upon specialized pedagogical knowledge graphs and adaptive engines, they dynamically generate personalized instructional strategies and provide real-time adaptive feedback.

Their operational logic is rooted in pedagogical theories (such as Constructivism and Sociocultural Theory), emphasizing the formation of a Cognitive Resonator through authentic pedagogical interactions. When acting as a proxy teacher, EAs necessitate the deconstruction of classical pedagogical models to provide expert-level guidance and stimulate deep cognitive processing. When assuming the role of a learning companion, they simulate social interaction patterns, driving the externalization of learner thinking and the internalization of knowledge through collaborative problem-solving or dialogue facilitating metacognitive monitoring.

Their core value lies in effecting a paradigm shift in education, transitioning from large-scale standardization to Precision Empowerment. They function simultaneously as: (1) a technical vehicle embodying pedagogical principles, and (2) a dialectical medium that reconfigures teacher-student subject relations and generates emergent pedagogical wisdom within human-AI collaborative scenarios.

Crucially, understanding their essential nature hinges on grasping their ontological status as co-constructive teaching entities. They represent neither a mere assemblage of instrumentalized technologies nor simply anthropomorphic functional mimicry. Instead, they are intelligent entities deeply embedded within the educational value network, generating pedagogical meaning through semantically potent actions.

2.2 The Evolutionary Logic of Educational Agents

The evolution of Educational Agents (EAs) constitutes not merely a linear technological progression, but a historical process involving the deep coupling of educational philosophy innovation, technological system breakthroughs, and changing societal demands. Its developmental trajectory distinctly manifests a logic of paradigm shifts: shifting from tool dependency to cognitive collaboration, from simplistic feedback to situational generation, and from functional modules to ecosystem sustainment.

Programmed instructional systems in the 1970s formed their primitive precursors. At that stage, agents operated as "behaviorist script executors", delivering standardized exercise feedback based on predefined rule chains. Their core limitation lay in the cognitive rigidity of closed systems – incapable of adaptively responding to learner variance and fundamentally divorced from the socio-cultural contexts essential for language acquisition.

Beginning in the 1990s, the advent of multimedia technology and intelligent algorithms catalyzed the emergence of the first generation of contextually responsive agents. CD-ROM interactive courseware simulated dynamic scenarios to construct foreign language context elements, while finite-state-machine-driven dialogue engines achieved basic semantic matching. Although still constrained by static knowledge bases at the cognitive level, this period marked the awakening of the embodied learning environment design paradigm.

The maturation of intelligent agent technology in the early 21st century triggered a second transition: agents formally ascended to become active participants within the pedagogical relationship. Multi-agent architectures (e.g., the Belief-Desire-Intention model) endowed them with goal-directed behavioral planning capabilities. Natural Language Processing (NLP) supported foundational language practice partners. Particularly in foreign language education, context-aware virtual agents (e.g., embodied conversational agents) enhanced linguistic communication contexts through nonverbal modalities (gaze/gesture). The fundamental breakthrough in this phase was the generation of interactional intersubjectivity: Bayesian Knowledge Tracing dynamically modeled learner states, enabling adaptation-driven corrective feedback by rule engines, thereby realizing a pedagogical shift from "stimulus-response" to "diagnosis-intervention". However, the demand for deeper interaction and the lack of interpretability in

complex systems led to an evolutionary bottleneck, trapping many systems within the predicament of being "low-cognitive-level scenario toys".

The current third wave of technological innovation, characterized by Large Language Models (LLMs), multimodal fusion, and embodied intelligence, is propelling educational agents towards evolution as trans-contextual cognitive collaborators: (1) Philosophical Reorientation: Agents are transitioning from "assistive tools" to symbiotic entities within the cognitive ecology – Transformer-based agents (e.g., GPT-Based Tutors) rebuild the authenticity of foreign language communication through contextualized dialogue, transforming the essence of interaction from "executing preset processes" to "negotiating pedagogical meaning". (2) Capability Dimensions: The evolutionary logic focuses on three critical linkages, namely, spatio-temporal perception and cultural context modeling activate deep language-culture learning; the establishment of empathy mechanisms, enabling "integration of cognition and affect"; and multi-agent collaborative frameworks (e.g., CSCL environments) construct sociocultural spaces for language learning, achieving the technological instantiation of Vygotsky's Sociocultural Theory.

Ultimately, this evolutionary logic points towards the establishment of an Adaptive Pedagogical Ecosystem – where the educational agent will function as a neural nexus, continuously reconfiguring the ontological relationship between teaching and learning through emergent intelligence.

3. Multidimensional Classification Framework for Educational Agents

Educational Agents (EAs), as embodied manifestations of Artificial Intelligence (AI) deeply integrated into the educational sphere, exhibit significant diversity in their forms and functionalities. To delineate their differential characteristics across multiple dimensions—including technological implementation, pedagogical role, and modality of interaction—it is critically necessary to construct a multidimensional classification framework that transcends singular technological perspectives. This framework provides a systematic deconstruction based on four key dimensions: functional archetype, pedagogical role alignment, interaction modality, and deployment tier, offering a structured analytical pathway for subsequent theoretical refinement and practical exploration. Firstly, the Functional Archetype dimension focuses on the core technological implementation mechanisms and the capabilities boundary of the agent. Within this dimension, distinct types can be identified: Agent-type EAs typically possess a high degree of autonomy, enabling them to independently execute specific pedagogical tasks or simulate teacher-student interactions; conversely, Cognitive Augmenter-type EAs primarily function as intelligent aids or learning companions, aiming to enhance human cognitive capabilities by providing support such as real-time translation, grammar checking (particularly for foreign language writing), and personalized content delivery.

Secondly, the Pedagogical Role Alignment dimension pertains to the agent's functional positioning within teaching and learning scenarios. Based on their behavioral logic and goal orientation, EAs can be categorized into roles as a Teaching Tool, a Teaching Assistant, a Learning Peer, or a Simulated Tutor: ranging from a tool that merely executes instructions, through an assistant undertaking partial teaching organization and management tasks, to a peer simulating peer learner behaviour to stimulate collaboration, culminating in a tutor role capable of simulating expert teachers by delivering knowledge explanations, personalized feedback, and strategy modeling. Thirdly, the Interaction Modality dimension examines the core channels enabling human-agent collaboration. Within this dimension, the evolution from unimodal to integrated multimodal interaction is particularly critical. Multimodal interactions demonstrably possess superior capability for supporting complex pedagogical scenarios and represent a vital developmental direction towards natural and efficient human-agent collaboration. Finally, the Deployment Tier dimension reveals variances in their embeddedness within the educational ecosystem, encompassing spatial scope and systemic level. This dimension ranges from embedded application-layer agents, to standalone platform-level/course-level agents, culminating in ecosystem-wide generic interdisciplinary intelligent tutors; the operational complexity and system integration requirements increase significantly with each ascending tier.

This multidimensional classification framework, integrating technological, pedagogical, and human-computer interaction logics, aims to provide the academic community with a consolidated theoretical tool for clarifying the diverse manifestations of EAs. It also establishes a robust typological foundation for the precise selection, design, and evaluation of agents tailored to specific educational contexts, thereby effectively facilitating their transformative leap from merely being a "technological presence" towards becoming a "highly effective educational collaborator".

4. Application Value and Paradigm Innovation of Pedagogical Agents in Foreign Language Teaching

Pedagogical agents impart profound transformative potential to foreign language education by constructing intelligent, interactive, and adaptive language learning environments. Foremost among their core values is the precise facilitation of personalized learning pathways. Leveraging sophisticated algorithms, these agents conduct in-depth analyses of students' linguistic proficiency, cognitive styles, and even affective dispositions, thereby dynamically generating highly customized practice tasks and learning resources (Ahmed et al., 2024). This capability achieves the pedagogical ideal of genuinely personalized instruction, previously elusive in traditional classrooms. Furthermore, pedagogical agents redefine language skill cultivation by remedying the lack of authentic communicative contexts. Conversational virtual partners provide ubiquitous language

practice environments characterized by low anxiety thresholds and high-frequency interaction, simulating diverse purpose-driven contexts such as casual conversation, business negotiations, and academic debates. Critical to this process is the inherent instant feedback and diagnostic mechanism: agents accurately detect and analyze pronunciation errors, grammatical deviations, and pragmatic infelicities within milliseconds, offering explicit corrective suggestions and scaffolded guidance, which significantly accelerates language internalization. Additionally, agents grounded in gamification principles and human-agent affective interaction models demonstrably enhance learner motivation and social engagement, transforming monotonous drills into compelling, persistent learning activities. A particularly salient strength is their capacity to simulate discourse patterns and social conventions of characters from varied cultural backgrounds. Through multi-faceted interactions between learners and these digital cultural proxies, cross-cultural sensitivity is fostered in a subtle yet profound manner.

At the level of paradigm innovation, the burgeoning application of pedagogical agents is catalyzing a fundamental shift and the emergence of novel frameworks within foreign language education (Dai et al., 2022). The most profound innovation lies in the reconstruction of the teaching structure and central pedagogical actors: agents transition from peripheral supplementary tools to core roles as pedagogical agents and co-learners, concurrently prompting the teacher's role to migrate towards higher-order functions of context designer, cognitive catalyst, and AI-human synergy coordinator. Empowered by these agent capabilities, innovative instructional models continually emerge. The AI-driven adaptive learning model utilizes deep neural networks to continuously adapt learning difficulty, content granularity, and feedback modes in real-time, ensuring each student progresses within their optimal zone of proximal development (Tan et al., 2025). Simultaneously, AI-enhanced immersive Project-Based Learning (PBL) constructs highly realistic language task environments, compelling students to holistically hone language skills, critical thinking, and collaborative abilities while tackling tangible problems. The agent-supported distributed language experience is also gaining prominence. Leveraging Extended Reality (XR) and embodied agents, this modality constructs immersive communicative spaces within temporally or spatially altered environments (e.g., virtual international campuses, reconstructions of ancient city-states), furnishing learners with "embodied" language practice transcending physical classroom confines. Moreover, assessment and feedback mechanisms undergo intelligent transformation: pedagogical agents continuously and unobtrusively collect learners' digital footprints, employing analytical engines to generate dynamic competence profiles. These profiles comprehensively reflect the evolution of a learner's linguistic proficiency, utilization of cognitive strategies, and affective states, fundamentally transforming assessment from singular performance metrics to continuous process-oriented cognitive diagnosis and optimized intervention (Liu & Yuan, 2024). In essence, pedagogical agents represent far more than the superficial addition of tools; they serve as deep levers for the strategic transformation of foreign language education, reorienting it from content delivery to skill cultivation, from standardization to personalization, and from isolated classrooms to boundless "communities of practice".

5. Challenges and Reflection: Towards Human-AI Teaming for Intelligent Education

The deep integration of Educational Agents (EAs) within foreign language instruction faces multifaceted structural challenges. Technically, the semantic comprehension capabilities of existing agents remain constrained by algorithmic data biases, potentially resulting in culturally stereotypical outputs or logical fallacies during language generation in cross-cultural contexts (Tang et al., 2026). In educational practice, EAs' heavy reliance on pre-defined corpora for decision-making hinders their dynamic adaptation to real-time classroom interactions, leading to a disconnection between EA feedback mechanisms and authentic pedagogical situations. Ethically, significant challenges arise from the continuous collection of student vocal data, emotional states, and cognitive trajectories, creating a Privacy Paradox concerning personal data use. Furthermore, over-reliance on algorithmic assessment risks objectifying the teaching subject, potentially eroding the socio-emotional bonds between teachers and students (Hill & Knox, 2021). Most fundamentally, an intrinsic tension exists between EAs' standardized outputs and the inherent "learning differentiation" principle of foreign language pedagogy, necessitating rigorous validation of their efficacy in higher-order cognitive domains like dialect acquisition and literary appreciation.

Addressing these challenges requires the fundamental reconceptualization of intelligent education ecosystems through the core principle of "Human-AI Teaming". A critical pathway lies in establishing a dynamic hierarchical division of labor: EAs should be strategically positioned to handle procedural tasks such as language rule drilling and immediate grammar correction, thereby freeing teacher capacity to focus on cultivating metacognitive skills like cross-cultural critical thinking and emotional negotiation (Chiu et al., 2023). Technological advancements must shift from a unidirectional empowerment paradigm towards developing dual-channel adaptive models capable of sensing pedagogical intent. This involves leveraging multimodal data fusion for real-time instructional strategy optimization. At the institutional level, the implementation of a "dual-core certification mechanism" involving both human teachers and EAs is essential. Such a framework should integrate teachers' corrective actions on EA decisions into teaching evaluation systems to safeguard pedagogical authority (Holstein et al., 2019). Concurrently, an "Algorithmic Transparency Initiative" should enable teachers and students to trace EA decision pathways, demystifying technological authority. The ultimate objective is to forge responsible symbiotic systems where machines serve as

"cognitive scaffolding" rather than replacements (Shahin et al., 2026). Under this paradigm, teachers evolve from knowledge transmitters into learning ecosystem architects, realizing the "ontological transformation of education through technological empowerment" envisioned in the Education Informatization 2.0 Action Plan.

6. Conclusion

Pedagogical agents transcend mere instrumental applications, and their vigorous advancement heralds the dawning of a new era characterized by the profound integration of intelligence, education, and language. Through a deep understanding of their essential attributes—contextual interaction, dynamic adaptation, and collaborative evolution—and by employing a scientifically grounded, multidimensional classification framework to clarify their genealogical structure, we can more fully unlock their revolutionary potential. This potential lies in authenticating foreign language learning environments, refining personalized learning pathways, optimizing timely feedback and guidance, and concretizing cultural contexts.

The core value of foreign language education resides in its capacity to connect minds and bridge worlds. Pedagogical agents contribute to this value by leveraging technology to create enriched scenarios, enhance pedagogical methodologies, and broaden perspectives, thereby empowering human actors—the central agents—to realize these goals more seamlessly, dynamically, and profoundly. Adherence to the foundational principles of human-centered design, ethically-driven deployment, and learning empowerment is paramount. Guided by the practice of human-AI synergy and complementary strengths, and through sustained efforts to overcome critical bottlenecks, the future vision of intelligent foreign language education becomes clear: Educators will affirm their critical roles as master designers and value leaders; learners' agency and higher-order thinking will flourish within meticulously constructed human-AI integrated environments; and pedagogical agents will function as ubiquitous, intelligent, and trustworthy advanced partners and enhanced agencies. Together, they will co-construct a thriving new ecosystem for linguistic acquisition and cultural exchange. This transformative vision constitutes the collective imperative bestowed upon us by the educational digital transition and stands as a compelling testament to the enduring vitality of humanistic spirit within the intelligent age.

References

[1] Ahmed, N., Saha, A. K., Noman, M. A. A., Jim, J. R., Mridha, M. F., & Kabir, M. M. (2024). Deep learning-based natural language processing in human‐agent interaction: Applications, advancements and challenges. *Natural Language Processing Journal*, 9: 100112. https://doi.org/10.1016/j.nlp.2024.100112

[2] Baker, T., Smith, L., & Anissa, N. (2019). *Educ-AI-tion Rebooted? Exploring the Future of Artificial Intelligence in Schools and Colleges*. NESTA.

[3] Chiu, T. K. F., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic Literature Review on Opportunities, Challenges, and Future Research Recommendations of Artificial Intelligence in Education. *Computers and Education: Artificial Intelligence*, 4: 100118. https://doi.org/10.1016/j.caeai.2022.100118

[4] Dai, L., Jung, M. M., Postma, M., Louwerse, M. M. (2022). A systematic review of pedagogical agent research: Similarities, differences and unexplored aspects. *Computers & Education*, 190: 104607. https://doi.org/10.1016/j.compedu.2022.104607

[5] Hill, C. E., & Knox, S. (2021). *Essentials of consensual qualitative research*. American Psychological Association.

[6] Holstein, K., & Aleven, V. (2022). Designing for human–AI complementarity in K-12 education. *AI Magazine*, 43, 239-248. https://doi.org/10.1002/aaai.12058

[7] Liu, X., Tang, Q., Wu, W., Chen, X., & Wang, C. (2026). GenAI-agents in education: a systematic review of macro-level trends, educational roles, theoretical foundations and future agendas. *Interactive Learning Environments*, 1-23. https://doi.org/10.1080/10494820.2026.2672562

[8] Liu, B., & Yuan, D. (2024). Research on Personalized Teaching Strategies Based on Learner Profiles in a Blended Learning Environment. *International Journal of Information and Communication Technology Education*, 20(1), 1-23. https://doi.org/10.4018/IJICTE.346823

[9] Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence Unleashed: An Argument for AI in Education.* Pearson.

[10] Shahin, M., Maghanaki, M., & Chen, F. F. (2026). The symbiotic factory: a comprehensive framework for extending lean manufacturing to human-AI collaboration. *Expert Systems with Applications*, 314: 131606. https://doi.org/10.1016/j.eswa.2026.131606

[11] Sun, Y-Z., Sun, H-L., Ma, J-C., Zhang, P., Huang, X-Y. (2025). Multimodal Agent AI: A Survey of Recent Advances and Future Directions. *Journal of Computer Sciences and Technology*, 40, 1046-1063. https://doi.org/10.1007/s11390-025-4802-8

[12] Tan, L. Y., Hu, S., Yeo, D. J., Cheong, K. H. (2025). Artificial intelligence-enabled adaptive learning platforms: A review. *Computers and Education: Artificial Intelligence*, 9: 100429. https://doi.org/10.1016/j.caeai.2025.100429

[13] Tang, W., Zhu, M., Wu, F., Li, X., Liu, Y. (2026). Empowering Embodied Agents with Semantic Intelligence. In Y. Zhou, S. G. Teo, X. Xie, Z. Ding, &

Y. Liu (eds.), *Engineering of Complex Computer Systems* (pp. 480-485). ICECCS 2025. Lecture Notes in Computer Science, vol 15746. Springer, Cham.

[14] Wang, Y., Hong, D., & Huang, J. (2023). A Diffusion of Innovation Perspective for Digital Transformation on Education. *Procedia Computer Science*, 225, 2439-2448. https://doi.org/10.1016/j.procs.2023.10.235

[15] Wang, J., & Li, Y. (2026). AI and the future of educational technology: a systematic review of pedagogical innovations and challenges. *Cogent Education*, 13(1). https://doi.org/10.1080/2331186X.2026.2691562

[16] Zhang, L., & Lu, J. (2026). Contradictions and tensions in EFL learners' writing agency: An activity theory perspective. *Learning, Culture and Social Interaction*, 57: 100983. https://doi.org/10.1016/j.lcsi.2026.100983