Journal of International Education and Development
2025, VOL. 9, NO. 8, 233-235
DOI: 10.47297/wspiedWSP2516-250053.20250908

Research on the Cultivation of Human-Machine Collaborative Innovative Thinking in General Education of Private Colleges and Universities

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ABSTRACT

Against the backdrop of artificial intelligence reshaping the educational ecosystem, general education in private colleges and universities faces the "triple predicaments": the disconnection between knowledge transmission and industrial needs, the separation of theoretical teaching from practical application, and the gap between human-machine interaction and thinking empowerment. Guided by the Outline for Building a Powerful Education Nation (2024-2035), this study constructs a "POT-OBE+ 6E" human-machine collaboration theoretical framework. By integrating the Problem-Oriented Cognition Model (POT-OBE) with the 6E teaching paradigm (Engaging, Excitation, Exploration, Enhancement, Execution, Evaluation), it breaks through the limitations of the "knowledge logic" in traditional general education. In response to the resource constraints of private colleges, a "broad-specialized-innovative" three-level progressive curriculum system is proposed: at the broad level, a problem-driven path supported by an AI low-code platform is constructed; at the specialized level, progressive project training supported by lightweight tools is developed; at the innovative level, an interdisciplinary collaborative platform is built. Meanwhile, a dual-track mapping model of "human cognitive ability layer" and "AI collaborative ability layer" is established, forming a hierarchical training mechanism that realizes the leap from tool operation literacy to cognitive qualitative change. The research results provide a trinity path of "theoretical framework-curriculum system-ability training" for private colleges to cultivate innovative thinking, and contribute a promotable practical paradigm to the digital transformation of education.

KEYWORDS

General education; Innovative thinking; Human-machine collaboration

1 Introduction

In the era where generative artificial intelligence reconstructs the paradigm of knowledge production and dissemination, higher education is undergoing a paradigm shift from "knowledge storage" to "cognitive evolution"[1]. The Outline for Building a Powerful Education Nation (2025) explicitly proposes to "promote artificial intelligence to facilitate educational reform", requiring the higher education system to meet the development needs of the digital economy and deepen the reform of curriculum systems and thinking cultivation models [2]. As an important part of China's higher education, private colleges and universities are confronted with severe structural challenges in their general education.

Solidification of knowledge logic: The traditional "lecture-memory-reproduction" model struggles to cope with complex problems in the AI era, marginalizing the cultivation of students' innovative thinking [3]; The triple disconnection predicaments: the disconnection between knowledge transmission and industrial needs, between theoretical teaching and practical application, and between human-machine interaction and thinking empowerment, as revealed in the application report, are particularly prominent in private colleges due to weak technical literacy of teachers and limited practical resources; Superficial application of tools: Existing AI educational practices mostly focus on technical operation training, lacking a mechanism for collaborative empowerment of human cognitive abilities and AI auxiliary capabilities.

Although international academic circles have paid attention to the application of AI in education (such as MIT's creative learning spiral), no implementation path adapted to the resource characteristics of private colleges has been formed; Domestic reforms on the OBE model (such as studies by Li Shuai and Qin Yang) are mostly concentrated on professional courses, and the cultivation of human-machine collaborative innovation in the field of general education is still in the exploratory stage [4]. Based on this, this study takes the Problem-Oriented Cognition Model (POT-OBE) as the core, integrates constructivist theory and neuroscientific principles, and constructs a "POT-OBE+6E" human-machine collaboration framework, aiming to solve how to break the binary separation of "knowledge-practice", realize the transformation of general education from transmission to empowerment, and how to rely on lightweight AI toolchains to overcome the bottleneck in cultivating innovative thinking under the resource constraints of private colleges.

2 Construction of theoretical framework

Based on the core needs of educational paradigm transformation in the era of artificial intelligence, this study integrates multidisciplinary theoretical resources to form a "POT-OBE+6E" human-machine collaboration system with both scientificity and practical guidance [5]. Its logical starting point is to break through the limitation of the "knowledge logic" in traditional general education, which centers on linear knowledge transmission, and shift to a "problem logic"

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cognitive model oriented to problem-solving.

This framework, rooted in the Problem-Based Outcomes-Oriented Education (POT-OBE) model, integrates the reverse design principles of Outcome-Based Education (OBE) with the inquiry-based approach of Problem-Based Learning (PBL). It emphasizes that learning objectives should be anchored in real-world problem-solving competencies, while the learning process revolves around identifying, analyzing, and resolving problems. Building on this foundation, it incorporates the 6E teaching paradigm—Engagement, Excitation, Exploration, Enhancement, Execution, and Evaluation—creating a complete closed-loop system from cognitive activation to competency solidification. The "Participation" phase focuses on initial human-machine tool interactions, utilizing accessible AI tools to reduce technical cognitive load and provide equal entry paths for learners with varying foundations. The "Inspiration" phase leverages AI-assisted problem scenario creation to stimulate learners 'investigative curiosity and critical thinking, overcoming the traditional teaching dilemma of passive acceptance. The "Exploration" phase employs AI knowledge graphs and data analysis tools to support learners in multidimensional exploration of problem essence, achieving a leap from superficial observation to pattern recognition. The "Enhancement" phase promotes structured knowledge integration and transfer capacity cultivation through AI-assisted personalized learning path recommendations. The "Implementation" phase utilizes AI simulation platforms and collaborative tools to drive solution implementation and iterative optimization. The "Evaluation" phase combines human teachers' qualitative assessments with AI tools' quantitative analysis to deliver comprehensive feedback on cognitive processes and outcome quality.

3 Design of adaptation path for private colleges and universities

Building upon the "POT-OBE+6E" theoretical framework and considering the resource constraints of private universities along with students' cognitive characteristics, this study establishes an adaptive pathway through curriculum design and competency development mechanisms to bridge theoretical concepts with practical implementation. The "General-Specialized-Innovative" three-tier progressive curriculum system serves as the core mechanism for addressing resource bottlenecks in private higher education institutions.

The "Broad" curriculum forms the foundational layer of general education, spanning humanities, sciences, and technology. It establishes problem-driven cognitive foundations through low-code AI platforms (such as visual programming tools and knowledge graph generators). For instance, in the "University Computing" course, AI tools transform real-life scenarios (like community elderly care resource allocation) into data visualization challenges. This approach guides students to engage with tools (Engaging), abstract core contradictions, and develop first-principles thinking. This tier emphasizes lowering technical barriers, allowing students to experience a closed-loop cognitive process of "problem scenario, knowledge correlation, case practice" without requiring deep programming expertise.

The "Specialized" course module serves as a competency-building tier, focusing on specialized training in general technologies like AI and big data. By employing lightweight toolchains (such as AI code generation tools and data cleaning plugins), it reduces practical implementation challenges. Taking the elective "Python Programming" course as an example, its progressive project design follows a workflow of "case reproduction → functional expansion → autonomous optimization." Students transition from code imitation to logical innovation with AI assistance: AI tools aid in code enhancement (Enhancement), while instructors focus on algorithmic thinking guidance to strengthen "human-machine collaboration" technical transfer capabilities. This tier adapts to the current situation of weak technical literacy among faculty in private universities through lightweight tools and modular teaching modules, enabling controlled advancement of "technical depth."

The "Innovation" course serves as an incubation layer for creative development, focusing on interdisciplinary problem-solving. It forms a teaching team combining "specialized faculty + AI technology instructors + industry mentors," utilizing simulation platforms and automated testing tools to accelerate solution iteration. For instance, in the "Business Intelligence" course, students tackle real-world challenges like "Optimizing Cross-border E-commerce User Profiles." Through AI-assisted data analysis (Execution) and model development, they collaboratively complete the entire innovation process from solution design to prototype validation. This tier addresses the practical platform limitations of private universities by integrating corporate resources and AI tools, creating a closed-loop system of "Problem Solving → Evaluation & Reflection → Redesign."

4 Key challenges and response logic

When implementing human-machine collaborative general education, private colleges and universities need to face three core challenges: cognitive transformation, resource constraints and collaborative mechanism. The response logic should take into account both theoretical adaptability and practical feasibility.

The resistance to cognitive model transformation stems from the path dependence of traditional education's "knowledge logic" approach. Students have long been accustomed to the "passive reception—mechanical reproduction" learning pattern, creating adaptation barriers to the new paradigm of "problem-driven exploration and trial-and-error."

Some teachers resist role transformation due to concerns about AI tools replacing teaching value. Strategies include: embedding "AI-human collaboration advantage comparison" case studies in the Engaging phase of the 6E framework, such as demonstrating human-machine synergy through experiments comparing AI-generated reports with human critical analysis; establishing a "teacher thinking guidance competency certification system," incorporating AI tool application into teaching evaluations, and facilitating educators' transition from "knowledge transmitters" to "innovation coaches."

The resource constraints in private higher education institutions present two key challenges: First, limited technical resources make it difficult to afford high-end AI platforms; second, the technical proficiency of faculty and students remains inadequate, with complex tools posing significant barriers. The solution focuses on "lightweight + dynamic adaptation": In tool selection, prioritize open-source platforms (such as low-code development tools and free educational versions of large models) to reduce hardware investment; in curriculum design, develop "basic-advanced" toolkits. For students with weaker technical foundations, provide AI application modules with preset templates (e.g., automated survey generation), while offering customizable interfaces for more capable students, achieving efficient resource utilization through "tailored teaching" approaches.

The core challenge in cross-disciplinary collaboration stems from knowledge barriers and conflicting objectives among teaching teams. While academic instructors focus on cultivating disciplinary thinking, computer science educators emphasize technical implementation, and industry mentors prioritize practical application – these three stakeholders often fail to coordinate effectively. The solution lies in establishing a collaborative platform anchored by an "AI toolchain": By sharing AI simulation environments (e.g., cross-border e-commerce scenario platforms), all parties can collaborate under unified problem scenarios. A "contribution quantification mechanism" should be implemented, incorporating project resources from industry mentors and technical support from computer science teachers into course evaluations. This approach clarifies responsibilities across stakeholders, creating a sustainable collaborative model of "joint problem-solving, co-creation of solutions, and shared outcomes".

5 Conclusion

This study addresses the "triple disconnection" dilemma in general education at private universities, guided by the "Artificial Intelligence Empowering Educational Transformation" initiative from China's Education Powerhouse Development Plan. We developed a "POT-OBE+6E" human-machine collaborative theoretical framework, creating an innovative thinking cultivation program integrating three dimensions: theoretical framework, curriculum system, and competency mechanism. Theoretically, this study pioneers the integration of problem-oriented cognitive models, outcome-based education, and the 6E teaching paradigm. It breaks through the limitations of traditional general education's "knowledge logic", revealing the intrinsic mechanism of human-machine collaboration evolving from "instrumental operation" to "cognitive evolution", thereby providing a new theoretical perspective for educational digital transformation. Practically, the "broad-specialized-innovative" three-tier curriculum system adapts lightweight AI toolchains to private university resources, transforming abstract innovation cultivation concepts into actionable teaching processes. The "dual-track competency mechanism" addresses fragmented innovation training through hierarchical mapping of human and AI capabilities, establishing clear skill development pathways for students.

Funding

Liaoning Provincial Private Education Association Project in 2025, Title: Research on the Cultivation of Human-Machine Collaborative Innovative Thinking in General Education of Private Colleges and Universities,(ON: LMJX2025210)

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