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Research Article

Research on the Practice Pathways and Effectiveness Evaluation of Artificial Intelligence Empowering Higher Education in China

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Abstract

At present, artificial intelligence technology is reshaping the operational logic and organizational forms of higher education with unprecedented depth and breadth. The breakthrough of generative AI, represented by ChatGPT and DeepSeek, marks a role shift for AI from an auxiliary tool to a collaborative partner, exerting a paradigmatic impact on higher education—the core domain of knowledge production and dissemination. Starting from the contemporary proposition of AI empowering higher education, this paper systematically analyses the enabling effects and potential risks of AI across three core domains: student learning, teacher instruction, and administrative management. It reveals the complex reality where "empowerment" and "constraint" coexist. Furthermore, it constructs a practical pathway framework for AI empowerment in higher education across four aspects: teaching, learning, management, and evaluation, while also proposing an indicator system and implementation strategies for effectiveness evaluation. The research reveals that AI significantly improves efficiency in well-structured tasks but poses a risk of tool substitution in ill-structured tasks. For faculty, AI presents both empowerment and constraint, with deep guidance and emotional connection remaining difficult to replace by technology. Administrators exhibit a "high willingness - high dependence" pattern, signalling a potential risk of core capability degradation that warrants vigilance.

Keywords: Artificial Intelligence; Higher Education; Empowerment Effect; Practice Pathways; Effectiveness Evaluation

A Contemporary Examination of AI Empowering Higher Education

Currently, artificial intelligence technology is reshaping the social fabric with unprecedented depth and breadth. The breakthrough of generative AI, represented by ChatGPT and DeepSeek, signifies AI's transition from an auxiliary tool to a collaborative partner, exerting a paradigmatic impact on higher education as the central arena for knowledge production and dissemination. Within this profound technological transformation, higher education is not

merely an object being reshaped by technology but should also be a proactive subject that responds to technological challenges and leads technology towards positive ends. China's "Outline of the Plan for Building a Leading Educational Power (2024-2035)" explicitly calls for "promoting AI to assist educational transformation," requiring efforts to "deepen the use of AI in building the teacher workforce" and to promote the restructuring of the education system through AI [1]. As the inaugural year of the "15th Five-Year Plan" period (2026-2030), systematically assessing the real impact of AI intervention in higher education, identifying its enabling effects and potential risks, has become a core issue demanding urgent attention in educational research.

From a technological evolution perspective, AI empowerment in education has undergone a three-stage paradigm shift. The first stage is "instrumental application" (2010-2018), where AI served as an auxiliary tool for tasks like searching educational resources, creating courseware, and grading assignments, characterized by a scattered, point-based application pattern. The second stage is "platform integration" (2018-2023), where AI became embedded in smart teaching platforms, enabling functions like classroom behaviour recognition, learning analytics, and personalized recommendations, beginning to permeate the entire teaching process. The third stage is "ecological restructuring" (2023-present), marked by the breakthrough of generative AI, elevating AI from a technical tool to the "operating system" of the educational system, driving systemic changes in teaching models, learning methods, and evaluation mechanisms [2]. Currently, Chinese universities are at a critical juncture transitioning from the second to the third stage, with some pioneering institutions conducting in-depth explorations in smart teaching, intelligent management, and precision evaluation.

Against this backdrop, a crucial question emerges: What exactly does AI bring to higher education? Existing research often focuses on technical function descriptions or empirical case studies, lacking systematic evaluations of empowerment effects and risk identification. On one hand, an optimistic expectation that AI will revolutionize educational paradigms dominates academic discourse. On the other hand, practical challenges such as tool substitution, capability degradation, and ethical risks have surfaced, demanding careful theoretical scrutiny. This study focuses on three core questions: What empowerment effects does AI generate across the three domains of student learning, teacher instruction, and administrative management? What potential risks does it face? What practice pathways and evaluation frameworks should be constructed? By systematically addressing these questions, this study aims to provide theoretical guidance for higher education reform in the age of AI.

Theoretical Implications and Practice Domains of AI Empowering Higher Education

Theoretical Logic of Empowerment Effects

The empowerment effect of AI on higher education can be understood through three theoretical dimensions, which together constitute the academic foundation for AI-empowered education.

First, Cognitive Offloading Theory. This theory posits that human cognitive systems are limited by working memory capacity and require external tools to extend cognitive abilities [3]. As an external cognitive tool, AI can undertake programmed cognitive tasks such as information retrieval, data organization, initial synthesis, and formatting, freeing up cognitive resources for learners to engage in deep processing, critical thinking, and creative construction. Research shows that for well-structured tasks (e.g., information retrieval, material organization), AI significantly improves learning efficiency and performance. However, cognitive offloading has boundaries: when learners offload too many cognitive tasks to AI, their own knowledge construction abilities and cognitive development may be inhibited.

Second, Human-Machine Collaboration Theory. This theory emphasizes that AI and learners together form an iterative cycle encompassing raising questions, generating content, evaluating content, and refining content, promoting progressively deeper cognitive levels through multi-turn dialogues. In a human-machine collaborative learning model, AI does not serve as a repository of standard answers but as a conversational partner that stimulates thinking and guides inquiry. Effective AI-assisted learning follows this closed loop from question formulation to content refinement. Throughout this cycle, the learner's agency remains paramount, with AI serving, not substituting, the human thinking process.

Third, Differentiated Instruction Theory. This theory posits that students exhibit individual differences in cognitive levels, learning styles, and interests, and effective teaching must respond to these differences. AI can push differentiated learning content and appropriately difficult practice tasks based on learners' individual characteristics, achieving an organic unity of large-scale education and personalized cultivation [4]. Applications like personalized learning pathway recommendations, adaptive learning systems, and intelligent learning diagnosis represent technological implementations of differentiated instruction theory in the AI era. However, the occurrence of empowerment effects is not unconditional. Research indicates that the effectiveness of AI empowerment depends on three variables: the clarity of task structure—AI shows clear advantages in well-structured tasks but poses substitution risks in ill-structured tasks; the user's AI literacy—higher literacy correlates with more significant empowerment effects but may also bring higher dependency; and the depth of human-machine collaboration—shallow question-answer exchanges rarely produce deep learning effects, while deep iterative dialogues foster cognitive development.

Three Core Practice Domains

The domains where AI empowers higher education can be divided into three interconnected core areas, each exhibiting distinct empowerment characteristics and risk patterns.

First, the Student Learning Domain. AI's impact on students presents a coexistence of "efficiency enhancement and burden reduction" with "tool substitution." For structured tasks like information retrieval, literature organization, code generation, and data visualization, AI acts as an efficient external cognitive

tool, significantly improving learning efficiency and performance. A study at the University of Electronic Science and Technology of China showed that students using AI assistance for literature reviews reduced their average time from 12 hours to 4 hours, while tripling literature coverage [5]. However, for open-ended, creative tasks, although superficial performance metrics may improve, high scores might primarily be driven by AI-generated content, revealing a deep-seated risk of tool substitution. Research shows that students overly reliant on AI for assignments demonstrate significantly poorer performance when completing tasks independently later. Concurrently, AI use significantly amplifies students' privacy concerns and negatively impacts social development dimensions like teacher-student relationships and perceptions of teamwork collaboration. Some students report that "increased interaction with AI corresponds to decreased interaction with classmates and teachers."

Second, the Teacher Instruction Domain. AI presents both "empowerment and constraints" for faculty research and teaching. In research, AI can significantly improve efficiency in literature review, data analysis, grant proposal writing, and reference management [6]. Yet, studies simultaneously find that AI's impact on research quality enhancement is unclear, with risks of constraining independent thinking, weakening higher-order thinking, and increasing research homogeneity. In teaching, empirical research indicates that traditional face-to-face instruction still yields significantly better outcomes than pure AI teaching. The value of teachers' deep guidance, experience-based interactive adjustments, and emotional connection remains difficult to replace technologically. A reflective comment from a university professor is illustrative: "AI can help me grade assignments and create slides, but the spontaneous responses in class, the emotional care for students, the flexible handling of unexpected issues—that's the essence of teaching."

Third, the Administrative Management Domain. University administrators exhibit a characteristic of "high willingness - high dependence" in AI use. AI significantly improves efficiency in official document writing and comprehensive management, excelling in tasks like document drafting, information aggregation, data statistics, and workflow approvals. However, driven by an "efficiency first" mindset, a clear trend of technological dependence has emerged. Groups with higher AI literacy show greater dependence. Directly invoking AI-generated content exacerbates dependency; without deep processing and judgment, it may weaken professional judgment and decision-making autonomy.

Constructing Practice Pathways for AI Empowering Higher Education

Practice pathways for AI empowering higher education require coordinated advancement across four dimensions: teaching, learning, management, and evaluation. Currently, several universities have initiated deep explorations in this area, accumulating replicable and scalable exemplary experiences.

Smart Teaching: Innovation in Human-Machine Collaborative Teaching Models

Smart teaching is the core domain for AI empowerment in higher education. The key lies in moving from instrumental use of technology to human-machine collaborative development, forming a new teaching model characterized by "AI processes data, teachers focus on education, and humans and machines complement each other's strengths."

The practice at Beijing Jiaotong University offers a typical example in the field of instructional diagnosis. The university constructed a teaching quality diagnosis system covering three dimensions: "classroom - course - program." At the classroom level, the AI system deeply analyses recorded videos and generates reports from three aspects: teaching conditions, learning conditions, and classroom interaction. Within 10 minutes after a class ends, the teacher receives a detailed instructional quality diagnosis report, accurately recording attendance rates, front-row seating rates, students' head-up frequency (an indicator of attention), and analysing indicators like teacher speaking pace, question types, and depth of classroom interaction [7]. At the course level, the system reads student exam, quiz, and interaction data for each course, automatically generates course quality data, and calculates the overall achievement rate for various graduate attributes. At the program level, through horizontal comparison and vertical tracking, AI identifies weaknesses in program development and suggests adjustments. The core value of this system lies in making implicit teaching processes explicit and data-driven, providing evidence-based support for teacher reflection and improvement.

Another important direction for smart teaching is personalized learning support. Shandong University of Technology's "Jixia Smart Teaching" platform extensively constructs knowledge graphs, AI tools, and intelligent agents, achieving technology-enabled empowerment across the entire process, all scenarios, and all elements of teaching activities along business lines such as "smart teaching, personalized learning, multi-dimensional evaluation, and intelligent management."

Intelligent Management: Data-Driven Improvement of Governance Efficiency

The core of AI's empowerment in university administration lies in achieving a paradigm shift from "experience-based management" to "data-driven governance," using data flows to integrate business flows and decision flows, thereby enhancing governance efficiency.

The practice at Hunan University of Technology provides a typical example of intelligent management. The university developed a smart teaching management system covering the entire process of "teaching, learning, management, evaluation, and research," promoting the transformation of teaching management towards intelligent decision-making through data-driven approaches and process restructuring. Regarding academic management, an academic affairs intelligent agent system launched in 2025 was deeply embedded into WeChat campus cards. Students could complete 90% of academic inquiries—including schedule inquiries, grade checks, course registration applications, and student status

changes—through natural language conversations. For example, when a student asks "How to apply for recognition of innovation and entrepreneurship credits?", the system instantly retrieves their course grades and competition records, automatically generates an assessment report, and pushes the approval process, reducing processing time from the original 3 working days to 2 hours.

In terms of teacher development, the university established a digital teacher development center, fully digitizing teaching resources, growth trajectories, and training activities [2]. For instructional supervision, through AI video analysis, functions like real-time captioning, multi-language translation, word cloud extraction, and classroom behaviour analysis are accomplished. The AI classroom analysis system deeply processes recorded videos, intelligently matches classroom teaching quality and teacher-student behaviours with teaching plans, and generates class summaries and optimization suggestions. Statistics show that after the new system's implementation, the course scheduling conflict rate dropped to 0.3%, the online processing rate for student affairs reached 97%, teachers' administrative workload decreased by 35%, and the response speed for teaching anomalies improved to within 4 hours. These figures demonstrate that AI's empowerment effect in administrative management is significant and quantifiable.

Precision Evaluation: Whole-Process, Multi-Dimensional Quality Diagnosis

Teaching evaluation serves as a breakthrough point for AI empowerment in higher education. Traditional evaluation faces three major problems: limited monitoring methods, single evaluation models, and emphasis on monitoring over feedback. Evaluation often relies solely on final exams, with feedback lagging behind the teaching process. AI intervention offers new possibilities for solving these dilemmas.

In terms of evaluation dimensions, AI enables a shift from "single dimension" to "multi-dimensional, stereoscopic" assessment. Deep learning-based AI analysis models can automatically identify and quantitatively analyse key teaching behaviours such as teacher body language, gestures, vocal sentiment, and blackboard use. Concurrently, through learning focus detection models, they analyse student behavioural features like facial expressions, head-up rate (attention), and interaction frequency, establishing an assessment system for classroom participation and learning state based on indicators like front-row seating rate, head-up rate, and interaction rate. This multi-dimensional evaluation allows the teaching process to be presented comprehensively and from multiple angles.

In terms of evaluation timeliness, a shift from "delayed feedback" to "real-time diagnosis" occurs. Traditional end-of-semester student evaluations are "past tense" for the current cohort, making improvement difficult. AI systems can generate diagnostic reports within 10 minutes after each class and push them to teachers' mobile devices, allowing immediate instructional strategy adjustments. This real-time feedback mechanism enables evaluation to truly serve continuous teaching improvement.

Regarding evaluation agents, a new "human-machine collaborative" evaluation model emerges. Quantitative data provided by AI evaluation (attendance rates, attention levels, interaction rates) effectively compensates for the subjectivity of traditional human evaluation, significantly improving the consistency of evaluation results. Expert supervisors, conversely, focus on dimensions difficult for AI to judge, such as the depth of teaching content, its intellectual substance, and value orientation, forming a complementary pattern where AI enhances efficiency and teachers enhance quality [8]. This division of labour leverages AI's efficiency advantages while retaining human professional judgment, representing the most scalable evaluation model.

Effectiveness Evaluation and Risk Assessment of AI Empowering Higher Education

Empirical Findings on Empowerment Effects

Based on the white paper "Social Experiment on the Impact of Artificial Intelligence on Higher Education" released by the Digital Intelligence Governance Research Center of the University of Electronic Science and Technology of China, along with practical experiences from several universities including Beijing Jiaotong University, Henan University of Technology, and Hunan University of Technology, three core findings on AI's empowerment of higher education can be summarized.

At the student level, for well-structured tasks (e.g., information retrieval, material organization, code generation), AI acts as an efficient external cognitive tool, significantly enhancing learning efficiency and performance. However, for ill-structured tasks (e.g., open-ended, creative problems, value judgments), students may become "conveyors" rather than "creators" of AI-generated content. Concurrently, AI use significantly amplifies students' privacy concerns and negatively impacts social development dimensions like teacher-student relationships and teamwork perceptions [9]. This indicates that the empowerment effect of AI on students has boundaries and cannot be equated with an automatic improvement in educational quality.

At the teacher level, in research, AI can significantly improve efficiency in literature review, data analysis, grant proposal writing, and reference management. However, its impact on research quality enhancement is unclear, with risks of constraining researchers' independent thinking, weakening higher-order thinking, and increasing research homogeneity. In teaching, empirical research shows that traditional instruction still yields significantly better outcomes than pure AI teaching. The value of teachers' deep guidance, experience-based interactive adjustments, and emotional connection remains difficult to replace technologically. This implies that AI's role at the teacher level should be "assistance" rather than "substitution," and the core value of educators will not be negated by technological intervention.

At the administrator level, AI significantly enhances administrators' official document writing and comprehensive management capabilities, also generating positive effects on teaching ethics and team spirit [10]. However, driven by an "efficiency first" logic, a clear trend of technological dependence has emerged. Alarmingly, groups with higher AI literacy show greater dependence, and directly invoking AI-generated content

exacerbates this dependency. Without deep processing and judgment, this may weaken professional judgment and decision-making autonomy. This finding reminds us: technological empowerment and capability degradation can be two sides of the same coin, requiring careful management.

Systemic Risk Assessment

Based on the empirical findings above, AI empowerment in higher education faces six systemic risks, spanning various levels and actors within educational activities.

Core Capability Degradation Risk: Imbalance in human-machine collaboration is eroding higher-order thinking skills across actors. Over-reliance on AI for information retrieval, analysis, synthesis, and content generation may lead learners and researchers to lose their capacity for independent thought, critical judgment, and creative construction. "Outsourcing thinking" cedes core cognitive processes like knowledge construction, contradiction analysis, and systemic reflection to intelligent systems, placing human metacognitive abilities at risk of systemic degradation.

Imbalance in Interpersonal Relationships Risk: Excessive technological intervention weakens the affective ties within the educational domain. Teacher-student interaction and peer collaboration risk being replaced by "human-AI dialogue." Critical social interactions in education—eye contact in class, heart-to-heart talks after class, academic debate among peers—face marginalization. When students become more accustomed to talking with AI than with their teachers, the interpersonal warmth of education will inevitably be diluted [11].

Educational Equity Risk: Uneven effectiveness of technology use exacerbates existing structural gaps. Students with higher AI literacy and better technological access benefit more, while those with weaker digital skills or limited technological access may be further marginalized, creating an "AI divide." If left unaddressed, this gap could evolve into a new form of educational inequality.

Professional Ethics Risk: Blurred boundaries of technology application pose potential challenges to academic integrity and professional norms. Issues like AI ghost-writing, data fabrication, and plagiarism detection evasion urgently need regulation. Universities face unprecedented pressure in managing academic integrity [12]. Defining boundaries between technological convenience and academic norms is a challenge every university must confront.

Privacy and Data Security Risk: The "black box" nature of the technology and data retention cause a systemic crisis of trust. Comprehensive collection of teaching process data may involve sensitive information about teachers and students. Risks of leakage exist at every stage: data storage, transmission, and use. If mismanaged, AI-empowered education may come at the cost of sacrificing privacy.

Human Subjectivity Erosion Risk: This is the deepest and most insidious risk. Technological logic may usurp the essential logic of education. When AI can not only answer questions but also "raise questions," not only execute instructions but also "set goals," [13] human thinking autonomy and value judgment are eroded. The fundamental purpose of education is the free and comprehensive development of the human being. If technology, while empowering, dissolves human subjectivity, the result is self-defeating.

Indicator System for Effectiveness Evaluation

Scientifically evaluating the effectiveness of AI in higher education requires constructing a multi-dimensional assessment framework that both quantifies efficiency gains and identifies risks and hidden dangers. Based on existing research and practice, evaluation indicators across five dimensions are proposed, detailed in Table 1:

Table 1: Indicator System for Effectiveness Evaluation.

Evaluation Dimension	Specific Indicators
Teaching Dimension	Teacher AI Literacy (technical mastery, teaching integration, innovative application); Teaching Efficiency (reduction in lesson prep time, efficiency of resource development, reduction in administrative tasks); Teaching Quality (student satisfaction, knowledge mastery, ability development)
Learning Dimension	Learning Efficiency (compression ratio of task completion time, information acquisition efficiency); Learning Outcomes (depth of knowledge mastery, transfer application ability, innovative thinking development); Learning Experience (personalization satisfaction, learning initiative, technology dependence)
Management Dimension	Management Efficiency (compression ratio of transaction processing time, course scheduling conflict rate, online processing rate); Decision Quality (proportion of data-driven decisions, early warning accuracy, resource allocation rationality); Cost-Effectiveness (savings in human resources, resource utilization efficiency, input-output ratio)
Evaluation Dimension	Evaluation Coverage (full course coverage rate, whole-process recording rate); Evaluation Timeliness (feedback cycle, problem response speed); Evaluation Objectivity (proportion of quantitative indicators, scoring consistency, human-machine agreement)
Ethical Dimension	Data Security (completeness of encryption measures, strictness of access control, incidence of data breaches); Algorithmic Fairness (frequency of bias detection, implementation of fairness audits); Subjectivity Protection (retention space for autonomous decision-making, appropriateness of technological intervention, clarity of human-AI boundaries)

Conclusion: Value Reflection on AI Empowering Higher Education

The deep involvement of AI in higher education is not a simple technological upgrade or tool iteration, but a profound transformation concerning the essence of education, knowledge production, and human development [1]. The deep implication of this transformation lies in: when "thinking" can be outsourced, when "creation" can be generated, when "judgment" can be calculated, what is the role of education? What is the role of teachers? What is the role of humanity itself? These fundamental questions compel us to maintain clear theoretical awareness and value reflection in an era of rapid technological development.

Looking back at the history of education, every major technological change has prompted renewed questioning about the fate of education. From the advent of writing to the spread of printing, from radio and television to the rise of the internet, technology has never before approached the core of education—knowledge transmission and ability cultivation—as closely as it does today. The breakthrough of generative AI lies in the fact that it is no longer just a conveyor of knowledge but is beginning to act as a producer of knowledge. This role shift poses a fundamental challenge to the "knowledge transmission" model upon which education has long relied: if AI can provide standard answers anytime, if AI can generate high-quality papers and reports, if AI can simulate human teaching behaviour, then what is the unique and valuable purpose of education?

The answer lies not in technology, but outside of it. The fundamental purpose of education has never been the mechanical transmission of knowledge, but the holistic awakening of the human being—awakening the capacity for independent thought, awakening critical judgment, awakening the ability to discern values, awakening creativity and imagination, and awakening the emotional capacity and moral sensibility that define us as social beings. These are precisely the dimensions that current AI struggles to reach or replace. As this study reveals: AI demonstrates overwhelming superiority in well-structured tasks with clear rules. However, in ill-structured tasks requiring deep guidance, emotional connection, value judgment, and meaning-making, the presence of teachers, human judgment, and teacher-student interaction remains irreplaceable. This provides an important reference for defining the boundaries of AI empowerment in education: delegate repetitive, routine, low-cognitive-load tasks to AI, while reserving the core educational functions of stimulating thinking, guiding values, and cultivating emotions for teachers. Thus, an ideal pattern of human-machine collaboration and complementary strengths can be formed.

However, achieving this ideal is not automatic; it depends on systematic institutional design and continuous practical exploration. Currently, Chinese higher education stands at a critical window of opportunity, transitioning from "instrumental application" of AI to "ecological restructuring." The explorations of pioneering universities in smart teaching, intelligent management, and precision evaluation have already accumulated replicable and scalable exemplary experiences. Yet, we must also clearly recognize that these explorations are still in localized pilot phases, with significant gaps remaining before comprehensive rollout and systemic restructuring. More alarmingly, driven by an "efficiency first" logic, deep-seated risks like technological dependence, capability degradation, and subjectivity erosion are quietly accumulating. When administrators increasingly rely on AI for decision-making, when teachers increasingly rely on AI for instructional design, when students increasingly rely on AI for learning tasks, the questions "who is thinking?", "who is creating?", and "who is growing?" become unavoidable soul-searching inquiries.

Standing at the historical juncture of the inaugural year of the "15th Five-Year Plan," AI empowerment in higher education requires establishing clearer value coordinates. Technology serves people, not dominates them; efficiency serves quality, not replaces it; empowerment serves development, not erodes it. These three bottom-line principles should be the fundamental, non-transgressable tenets for AI-empowered education. AI will not replace teachers, but teachers who skilfully use AI will replace those who do not. AI will not dissolve education, but education that resists change will be eliminated by the times. In this profound educational transformation, the mission of higher education is not to passively adapt to technology, but to actively harness it; not to blindly chase efficiency, but to carefully safeguard values. As the light of technology illuminates the path ahead, we need the warmth of the humanities to illuminate the human heart. Only by finding the right balance between technology and the humanities can AI truly become a positive force driving high-quality educational development, rather than an alienating force that dissolves the essence of education. This is both the opportunity our times present us and the responsibility history has entrusted to us [14].

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Conflict of Interest

No conflict of interest.

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