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How can intelligent technology deeply empower education? — Exploring the practical pathways of the smart education paradigm

Hui Sun

School of Humanities and Arts, China University of Mining and Technology, Xuzhou, China

hellosunhui@126.com

Abstract. The surging wave of intelligent technology is profoundly reshaping the landscape of education, and the construction of a smart education paradigm stands as the core proposition in responding to this epochal transformation. As a critical arena of educational reform, institutions of higher education can only break through the impasse of cultivating innovative talents and propel the "student-centered" educational philosophy from vision to practice by thoroughly clarifying the intrinsic logic and practical imperatives of the smart education paradigm. The construction of this paradigm should reconcile the realistic tensions of contemporary development with the deep-seated concerns of humanistic spirit: centering on human development to manifest the humanistic warmth embedded in educational resources, interactions, and evaluations; aiming at the integration of knowledge and action to enhance the coherent efficacy across the chain of instructional activities; and bridging through industry-university collaboration to strengthen the adaptive capacity of educational practices to the demands of the times. At the confluence of technological advancement and cultural reflection, smart education fosters a future-oriented educational ecosystem that balances innovative efficiency with the warmth of human cultivation, thereby offering a referential pathway for the high-quality development of education in the intelligent age.

Keywords: intelligent technology, smart education, human-machine collaboration

1. Introduction

As a vital subject of education, institutions of higher learning must clarify the core connotation and realistic logic of the smart education paradigm in the age of artificial intelligence. Only in this way can they break the developmental predicament of insufficient innovation in China's higher education, lay pathways for constructing the student-centered smart education paradigm, and forge a new educational ecosystem suited to the artificial intelligence era. The term "paradigm" was never given an accurate conceptual definition by Thomas Kuhn upon its inception. In *The Structure of Scientific Revolutions*, he vaguely pointed out that "first, it forms an integrated community in terms of ideas and values; second, this community must generate problems to be solved by subsequent researchers" [1], leaving ample room for interpretative expansion. At present, researchers including Li Shuang define it as a structured system formed by the shared understanding

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of educational subjects regarding educational philosophies, teaching research methods, activity practice modes and other ontological and methodological dimensions. It follows that the educational paradigm covers all aspects of teaching philosophy, design and implementation. Its construction ought to abide by fundamental requirements: responding to the developmental demands of new quality productive forces, advancing systematic teaching reforms empowered by intelligent media technology, and complying with the inherent transformation laws of educational paradigms. A bastion of humanistic spirit can thereby be erected amid dynamic and cultural reforms.

2. People-oriented approach: elevating the humanistic standard of the smart education ecosystem

The modernization of education is not equivalent to technological modernization. On the contrary, technical "tools" must take educational "essence" as their ontology. "Chinese-style educational modernization must highlight the humanistic nature and autonomy of education" [2], with a focus on cultivating students' cognitive and aesthetic systems. Accordingly, educators ought to interpret the underlying logic of constructing the smart education paradigm from a perspective of cultural reflection and foster humanistic qualities within the smart education ecosystem. Specifically, a high humanistic standard demands dynamic coordination and coexistence among teachers and students, humans and machines, online and offline learning centered on humanity, both in coverage and depth. It requires humanistic attributes embedded in resource construction, interactive communication and educational evaluation alike.

The humanistic nature of resource construction lies primarily in shifting the focus from supply-side expansion to demand-side orientation, so as to cultivate generative clusters of teaching content. At the *World Digital Education Conference*, Huai Jinpeng, Minister of Education, noted that China now boasts nearly 30,000 high-quality Massive Open Online Courses (MOOCs) and almost 2,000 first-class courses, with educational platforms covering close to 200 countries and regions. Therefore, teaching resources should shift priority from quantitative expansion to qualitative improvement, evolving from fragmented, segmented single-format resources to multi-form, multi-level composite teaching resources built on complete disciplinary curricula. Such resources "develop into dynamic, three-dimensional and even four-dimensional teaching materials composed of audio, text, animation, images, videos and other elements" [3], diversifying channels for students to acquire knowledge.

Furthermore, artificial intelligence technology can capture students' authentic learning demands to dynamically adjust teaching material sets, courseware libraries and resource banks. Smart teaching curriculum teams should establish a core team of around three members to develop core modules, supported by a main team of five to eight members responsible for visualizing knowledge nodes and revising practical content. Notably, students' understandings and questions about teaching resources should be incorporated into the curriculum update mechanism, which calls for more flexible feedback channels on smart teaching platforms. The driving force behind generative teaching content derives not only from teachers but also from students, embodying the core tenet of modern curriculum development—the generative view of knowledge, particularly "living knowledge connected to students' personal experiences that can support the development of their creativity" [4].

The humanistic dimension of interaction in smart education extends beyond in-class emotional communication to fostering quasi-blood ties outside classrooms. The term "quasi-blood ties" refers to traditional teacher-student bonds originally built on geographical or occupational connections restricted by fixed teaching venues and environments. Long-term teaching practice gradually transforms these bonds into

quasi-blood teacher-student relationships, the very foundation upon which moral critique and moral core of teaching take shape. Nevertheless, online teaching spaces continuously deconstruct traditional physical classrooms, rendering quasi-blood teacher-student bonds increasingly fragile. To enhance the effectiveness of teaching reform, such bonds must be revitalized through intensified online and offline exchanges between teachers and students. Intelligent media terminals can transmit real-time physiological and behavioral signals including heart rate, facial expressions and body language between teachers and students. "Within teaching spaces, every individual influences and is influenced by others. The cultivation and development of interpersonal social emotions can never be replaced by any advanced tools" [3], enabling highly immersive personalized learning experiences.

Correspondingly, AI knowledge graphs enable refined evaluation within feedback systems. By analyzing students' assignments, interaction records, error patterns and other data, platforms can accurately draw personalized learning portraits, automatically generate chronological growth reports to track learning trajectories, compare performance across different stages, and mark students' strengths, learning styles and potential difficulties. Big data analytics excavate hard-to-quantify competencies such as individual contributions in collaborative learning and leadership in project work, visualized via radar charts and other formats. Evaluation subjects include joint teacher-student assessment, evaluation by teachers, students and enterprise mentors, as well as assessment aided by AI and knowledge graphs. Motivational evaluation runs through pre-class self-assessment, peer learning and post-class assessment. Through refined design, AI can act as a compassionate evaluator, allowing teachers to grasp teaching outcomes and students to perceive learning progress. This enables educators to comprehensively and deeply understand every student, fulfilling the service function of education.

3. Integration of knowledge and practice: boosting coherence across the smart education process

Reform of the smart education paradigm constitutes a systematic overhaul rather than scattered attempts or sporadic explorations. It delivers holistic teaching reform frameworks covering teaching philosophies, objectives, content and methodologies, realizing high coherence throughout knowledge generation, dissemination, comprehension and application. Every stage forms rigorous logical connections to enable smooth bidirectional transformation from knowledge to practice and practice to knowledge, constructing a closed-loop teaching activity chain. At present, digital teaching resources in universities often exist as fragmented, loosely connected materials with isolated knowledge points, leading students to engage in superficial browsing that "tends to result in greater knowledge loss than knowledge acquisition" [5]. The advancement of new quality productive forces relies on coordinated efforts from high-end precision industries and mid-to-low-end industries to form the agglomeration effect of complete industrial chains. Against the backdrop of deglobalization and the nationwide trend of full industrial chain construction, higher standards have been raised for differentiated disciplinary program design, personalized talent cultivation and high-end innovation. "Our knowledge is separated, dissected and compartmentalized across disciplines, while real-world issues grow increasingly multidisciplinary, transversal, multi-dimensional, transnational, holistic and global" [6]. For this reason, educational processes must pursue high coherence between knowledge and practice. Within closed-loop teaching chains, communities of teachers, students and faculty co-create learning, enabling continuous self-renewal of knowledge, competence and aesthetic literacy like perpetual motion machines.

High coherence in smart education processes encompasses one guiding awareness, two role transformations and three progressive stages. The single guiding awareness refers to a clear application-oriented mindset, or problem awareness, embedded across all educational workflows, ensuring theoretical knowledge equips learners to resolve real-world problems and adapt to future life. Current redundant, homogeneous teaching resources and passive learning modes reflect insufficient commitment to embedding application awareness in educational practice, rendering teaching activities disjointed and disorderly. Guided by application awareness, regionally distinctive living teaching materials can be developed to serve local economic development. Cumbersome, fragmented knowledge points are streamlined to build hyperlinked knowledge graphs and cross-disciplinary component systems instead.

Driven by integrated application concepts, school-local symbiosis and industry-university-research collaboration facilitate translating knowledge into new quality productive forces. "Linking curriculum content to social reality and students' personal experience constitutes the fundamental solution to disconnects between theory and practice" [4]. The two role transformations refer to shifts for teachers and students respectively: from traditional instructors and recipients to consulting service providers and active knowledge constructors. As information storage is no longer constrained by time and space, teaching centered on knowledge transmission gives way to focus on disciplinary principles and their discovery processes, cultivating students' higher-order thinking skills. Students take charge of active knowledge construction, peer learning and in-depth exploration throughout studies. Supported by artificial intelligence, teachers primarily act as service providers who redesign learning environments and accommodate differentiated learning capacities. These two roles stand as equal co-subjects without hierarchical distinction, collaborating closely to achieve integrated teaching of knowledge and practice.

The three progressive stages implement tiered teaching—mastering theories, applying knowledge and conducting practical work—to nurture students' innovative thinking capacities. Stage One—Mastering Theories: Students access flexible online video series to organize fragmented knowledge individually. Case-based teaching in classrooms guides reasoning through real cases. "Teaching's ultimate goal lies in enabling students to perceive, experience and undergo scenarios through all sensory channels, reconstructing new conceptual frameworks on the basis of pre-existing knowledge structures" [3], consolidating professional foundations. Stage Two—Applying Knowledge: Student groups collaboratively resolve cases or scenarios assigned by instructors, improving comprehensive complex problem-solving capabilities and fostering social responsibility. Stage Three—Conducting Practical Work: Project-based teaching centered on authentic social issues extends theoretical learning to real social environments, effectively integrating knowledge and practice and marking the cultivation of students' higher-order competencies.

Notably, after project-based teaching, teachers and students sort through project challenges for reflection, compile outcome reports, and feed these materials back into theoretical learning in Stage One, which in turn reinforces Stages Two and Three to drive iterative updates of all teaching phases. The single application awareness serves as the core orientation of coherent educational processes, the two role transformations act as primary driving forces for implementation, and the three progressive stages form tiered operational steps. Together they create a closed-loop interactive smart teaching reform model.

4. Industry-university-research integration: enhancing adaptability of smart education practice

Constructing the smart education paradigm is both a theoretical and practical proposition. Beyond macro inquiries into its connotations and significance, priority should be placed on practical implementation

pathways, alignment between academic research and industrial application, and generative teaching practice. Current industrial upgrading raises growing demand for interdisciplinary talents with integrated liberal arts and science competencies, yet practical teaching still suffers from overemphasis on academic theory while neglecting practical abilities. This mismatch between school education and labor market demands weakens supply-side momentum and intensifies employment pressures.

Smart education is future-oriented, guiding students toward fulfilling lives. While upholding classic academic principles, it deeply embeds education within real life and industrial practice to balance academic learning and professional practice, realizing dynamic equilibrium between students' knowledge management and comprehensive competencies. First, such balance requires constructing cross-disciplinary professional knowledge graphs. Talent cultivation objectives are designed sequentially across university, college, major and curriculum levels with tight logical links, among which curricula represent the most critical vehicle to fulfill cultivation goals. Responding to social demand for interdisciplinary talents and educational pursuit of innovative talent development, professional knowledge graphs must be outcome-oriented with rigorous internal logical connections. These graphs sort out curriculum relationships, identify duplicated or missing knowledge points, clarify interconnections between different courses and concepts, integrate classic theories with emerging hot-case studies, expand knowledge frameworks through trending events and terminology, and dissect theoretical formation mechanisms to continuously refine systematic professional knowledge frameworks.

Second, autonomous learning of interdisciplinary micro-majors should be encouraged, with universities or professional institutions issuing corresponding skill certificates to students who master cross-disciplinary knowledge and competencies. The setup of such "1+X" interdisciplinary micro-majors, supplemented by cutting-edge courses on artificial intelligence, industrial manufacturing and other frontier technologies, will emerge as a new driving force transforming interdisciplinary educational paradigms. Cross-disciplinary teaching aligns with the demand of new quality productive forces for talents with cross-boundary capabilities. "Cross-boundary integration competencies require talents supporting new quality productive forces to adopt cross-industry and cross-disciplinary thinking, break disciplinary and knowledge boundaries, and propose innovative solutions from integrated perspectives" [7]. Cross-disciplinary education therefore embodies broad university-wide and holistic educational concepts, while responding to the call of new quality productive forces for talents with robust intellectual curiosity and exploratory spirit.

A second dimension of high adaptability in smart education practice refers to the alignment between students' cognitive system development and behavioral cultivation. "Students' learning constitutes 'value guidance' and independent construction grounded in practical and communicative activities" [8]. Practical learning venues are no longer limited to classroom case scenarios. Though case-based teaching connects theory and reality closely to generate knowledge through equal dialogue, such simulated scenarios lack full authenticity, which can only be found in real life. Accordingly, establishing industry-university-research cooperation and school-enterprise partnerships to build future industrial alliances stands as a core pathway to construct smart education practice. "Carrying out collaborative innovation across industry, university and research institutes places industrial and academic sectors on equal cooperative footing, enabling systematic participation of multiple stakeholders" [9]. Collaborative innovation teams combining university faculty, entrepreneurs and investors, supported by AI teaching assistants, standardize benefit distribution and track the full incubation process of research outcomes. Through exposure to typical industrial challenges and real workplace experiences, students develop entrepreneurial and innovative mindsets deeply rooted in market and social realities, forming complete industrialization chains for research outputs.

In the artificial intelligence era, Internet Plus, especially the integration of generative artificial intelligence, empowers education modernization across all dimensions of teaching and learning with intricate, far-reaching impacts. Undoubtedly, discussing educational modernization in isolation from the intelligent media era ignores its objective foundation. As artificial intelligence expands from entertainment to learning and work domains, comprehensive reform of the smart education paradigm has only just begun. The proposition of new quality productive forces and empowerment via intelligent media technology provide fertile ground for such reforms. Evolving from computer-aided and data-driven educational paradigms, the smart education paradigm has become the most widely recognized and promising direction for educational reform under artificial intelligence. As direct responders to societal development, universities nurture genuine AI natives. They foster a smart education ecosystem with profound humanistic qualities, implement highly coherent teaching workflows, and advance highly adaptive educational practice, fully unlocking individuals' innovative thinking and imaginative potential. Guided by the smart education paradigm, universities navigate diverse possibilities for future education. "The development of new quality productive forces and higher education are closely interconnected, mutually supportive and mutually reinforcing" [10]. Triggered by reforms to the smart education paradigm, reciprocal progress will be achieved between foundational and frontier research, classical and modern theories, meticulous refinement and exploratory innovation alike.

5. Conclusion

Constructing the smart education paradigm is far more than simple accumulation of technical tools. Driven jointly by technological breakthroughs and cultural reflection, it delivers holistic reconstruction of educational philosophies, teaching methodologies and practical models. As a core venue for educational reform, universities must root themselves in the student-centered value foundation, embed humanistic warmth within educational ecosystems, improve coherence across teaching chains, and strengthen alignment between educational practice and real-world demands. These three mutually supportive, progressive dimensions form a systematic pathway translating the smart education paradigm from conceptual frameworks to on-the-ground implementation, addressing the contemporary demand for innovative talent cultivation brought by new quality productive forces and fundamentally resolving the predicament of insufficient innovation in higher education.

With deep integration of artificial intelligence, big data, learning analytics and other technologies, prominent challenges emerge including expanding boundaries of educational data collection, transparency of algorithmic decision-making, and appropriateness of technological application. The smart education paradigm urgently requires an ethical framework balancing efficiency and equity, privacy protection and learner autonomy. Looking ahead, further advancement of the smart education paradigm demands sustained exploration of critical topics including technological ethics, transformation of teachers' roles and reconstruction of evaluation systems. Only by maintaining dynamic equilibrium between technological innovation and humanistic care can smart education transcend instrumental rationality and evolve into a lasting driving force for high-quality educational development, opening new prospects for talent cultivation in the intelligent age.

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