

Empowerment and Transformation: Mechanisms and Pathways for the Development of New-Type Talents from the Integrated Perspective of Education, Science and Technology, and Human Resources

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Abstract

In the new journey of comprehensively building a modern socialist country, the integrated development of education, science and technology, and human resources has become a strategic foundation for constructing national core competitiveness. Based on the dynamic ecosystem formed by these three elements, this paper focuses on “educational technology” as a key coupling agent. From an interdisciplinary perspective of systems theory and pedagogy, it deeply analyzes how educational technology reshapes the paradigm of talent development. Furthermore, it proposes a full-chain mechanism centered on “data-driven processes, intelligent empowerment, digital profiling, platform connectivity, and closed-loop feedback,” providing theoretical support and practical pathways for promoting the modernization of the education system.

Keywords

Educational technology; Integrated development; Talent development; Personalized learning; Industry-education integration; Reform of educational evaluation

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1. Introduction

Currently, profound changes unseen in a century are accelerating across the world. The deep integration of education, science and technology, and human resources has become a key variable in promoting the construction of a national innovation system. This marks a shift in the relationship among the three from a one-dimensional linear model to a multidimensional, mutually constructive systemic one. In this context, educational

technology, serving as the “neural hub” connecting all three, has transcended its instrumental role to become a core force driving fundamental transformation in talent development paradigms. Therefore, systematically exploring the internal mechanisms and practical pathways through which educational technology empowers talent development from an integrated perspective holds significant theoretical innovation value and policy guidance significance.

2. The systemic logic and coupling mechanism of the integrated development of education, science and technology, and human resources

In the current era of unprecedented acceleration in innovation, the relationship among education, science and technology, and human resources has moved beyond the traditional linear paradigm of “education cultivates talents → talents drive science and technology → science and technology feeds back into education.” Within this system, education, science and technology, and human resources constitute three core nodes, engaged in immediate, multidimensional, and nonlinear strong interactions. Considering “system coupling degree” and “knowledge flow intensity”, it is evident that educational technology serves a dual function as both a “system coupling agent” and a “flow accelerator”^[1,2].

2.1. Education: The foundational layer: Unifying knowledge production and value shaping

Education is no longer merely a passive transmitter of knowledge. Through interdisciplinary integration and research feeding back into teaching, it has directly become the source of innovation for science and technology and the “forge” for cultivating innovative capabilities in talent. A high-quality education system supplies fresh forces with solid knowledge and an exploratory spirit for scientific and technological innovation, and cultivates builders for all sectors of social development.

2.2. Science and technology: The driving layer: Reshaping educational forms and competency structures

Science and technology are no longer distant outputs of education but are deeply embedded in the educational process as disruptive variables. For instance, AI enabling personalized learning and virtual simulation reshaping experimental teaching. These directly reshape educational forms and talent competency structures, while also giving rise to new research paradigms. Cutting-edge technologies such as AI, big data, and virtual reality not only innovate teaching tools but also profoundly reconstruct the educational ecology, spawning new talent demands and competency standards.

2.3. Human resources: The value layer: The hub of innovative practice and systemic feedback

Human resources serve as the hub of all value creation. They are not only the carriers of educational outcomes and technological applications but also, through their innovative practices and cross-boundary mobility, continuously inject new vitality into educational content and the frontiers of science and technology, becoming the fundamental driving force for system iteration. Various types of talent feed back into educational content through scientific and technological innovation activities, validate educational effectiveness through social practice, and ultimately drive social progress, achieving a closed loop of systemic value.

Under this logic, the role of educational technology lies in accelerating the flow speed and operational efficiency of this cycle, enabling education to better respond to the demands of scientific and technological development and the era for talent. The education system becomes more intelligent and efficient due to technological empowerment; scientific and technological development gains greater innovative vitality through educational support and talent drive; and the quality of talent is comprehensively enhanced within a superior educational environment and more advanced technological setting (**Figure 1**).

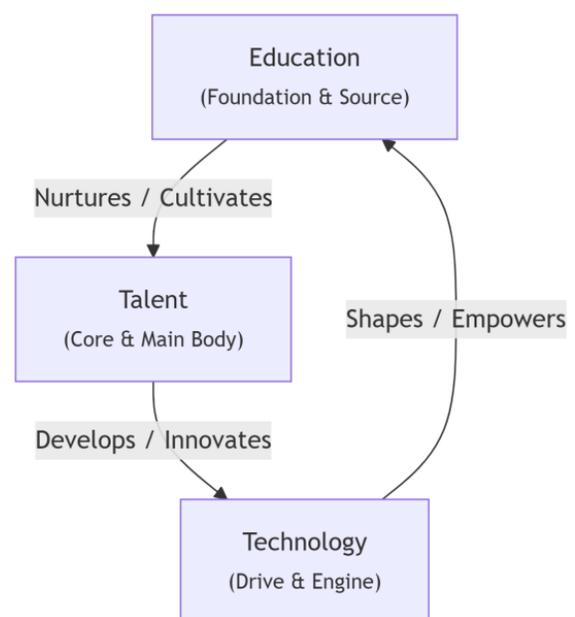


Figure 1. The coupling mechanism for the integrated development of education, science and technology, and human resources.

3. The connotation and development requirements of new-type talents

Within the ecosystem of integrated development of education, science and technology, and human resources, the new-type talents referred to today are by no means a simple upgrade of traditional knowledge-based talents. Instead, they represent a fundamental transformation in the development paradigm, constituting a “new-quality subject.” Their connotation and characteristics are shaped by this dynamic ecosystem and directly respond to the core challenges and developmental needs of the new era.

3.1. Defining the connotation: From “Instrumental” executors to “Innovative” subjects

Talents cultivated under the traditional industrial-era education model were often viewed as “instrumental” executors possessing specific knowledge and skills to serve particular production stages. From the integrated perspective of education, science and technology, and human resources, the core connotation of new-type talents lies in being “value-creating subjects” capable of proactively adapting to and leading technological transformations, and driving innovation within complex systems^[3]. They possess the following three core traits.

3.1.1. Integrated knowledge structure

The knowledge system of new-type talents is interdisciplinary and networked. They are not only proficient in a specific professional domain (the depth of a “T-shaped” talent) but can also integrate knowledge from multiple disciplines, such as science, technology, engineering, arts, mathematics, and even humanities and social sciences (the breadth of a “T-shaped” talent), forming a “holistic perspective” to address complex problems. Educational technology, by providing interdisciplinary online courses, virtual simulation projects, and knowledge graph tools, offers unprecedented possibilities for constructing such an integrated knowledge structure.

3.1.2. Proactive competency spectrum

The core competency of new-type talents shifts from “knowledge storage and application” to “problem discovery and innovation drive.” This requires them to

possess the abilities as follows:

- (1) Critical thinking and complex problem-solving ability: The ability to define ambiguous, cross-domain unstructured problems based on sifting through vast amounts of information and to design innovative solutions;
- (2) Human-machine collaborative innovation capability: Rather than competing with AI, they excel at utilizing AI as an “external brain” for data insight, pattern recognition, and assisted decision-making, combining human creativity, empathy, and strategic thinking with machine computational power and efficiency to co-create new value;
- (3) Continuous iterative self-directed learning ability: In an era where the half-life of knowledge is drastically shortening, the ability to utilize digital learning resources, learning communities, and intelligent tutoring systems to autonomously plan learning pathways, achieving continuous knowledge renewal and dynamic competency reshaping.

3.1.3. Guiding value orientation

New-type talents bear higher ethical and social responsibilities. They should possess a strong sense of technology ethics, data security awareness, and social responsibility, ensuring that scientific and technological innovation develops along an ethical track, serving the overall well-being of humanity and sustainable development goals.

3.2. Core characteristics: Six pillars for the future

Specifically, new-type talents exhibit the following six distinct characteristics, which are also the directions the education system needs to focus on cultivating as follows:

- (1) Digital literacy and technology acumen: Going beyond basic computer operation, this involves a fundamental understanding and application ability of new-generation information technologies (e.g., AI, big data, blockchain) and a critical awareness of their social impact. They are “users” and “understanders” of technology, not passive “recipients;”

- (2) Interdisciplinary integration and systems thinking: The ability to break down disciplinary barriers, examine issues from multiple dimensions, understand inherent connections between things, and integrate knowledge, methods, and techniques from different fields to form systemic solutions;
 - (3) Innovation spirit and creative tension: Dissatisfaction with the status quo, the courage to challenge authority, skill in exploring new knowledge amidst uncertainty, and possessing the driving force and resilience to translate ideas into practice;
 - (4) Collaboration and cross-cultural communication: In the context of globalization and the normalization of remote work, the ability to collaborate efficiently with team members from diverse professional and cultural backgrounds, both offline and online, to complete complex tasks;
 - (5) Growth mindset and resilience: A belief that abilities can be improved through effort, viewing challenges as learning opportunities, and maintaining a positive attitude while quickly adapting in the face of failure and rapidly changing environments;
 - (6) Value rationality and humanistic concern: While pursuing technological efficiency, maintaining insight into and care for humanity, and being capable of prudent reflection on the socio-ethical consequences of technology application, ensuring that technological development is “for good.”
- and innovative development;
 - (2) Shift in content, from “Fixed Curriculum” to “Dynamic Knowledge Ecology”: Curriculum content needs to transform from a static, closed system into a dynamically updated, “living” ecosystem closely linked to the frontiers of science and technology and industrial practice. Educational technology plays a key role here by linking global knowledge bases and real-time industrial data, ensuring the currency and relevance of learning content;
 - (3) Shift in methods, from “Standardized Instruction” to “Personalized Learning”: Based on precise profiling through big data and AI, education can provide customized learning pathways, resources, and guidance for each student, truly realizing the shift from a “teacher-centered” to a “learner-centered” approach, unleashing the unique potential of each individual;
 - (4) Shift in evaluation, from “Single Score” to “Comprehensive Digital Profile”: The evaluation system needs to move beyond assessing memorized and procedural knowledge towards multidimensional, process-based assessment of higher-order abilities such as critical thinking, collaboration, and the innovation process. Utilizing educational technology, a “digital profile” recording students’ growth trajectories can be constructed, comprehensively reflecting their competency development and literacy formation;
 - (5) Shift in context, from “Closed Campus” to “Borderless Learning Space”: The physical and spatiotemporal boundaries of learning are being dissolved. Practice bases for industry-education integration, online learning communities, virtual research and innovation platforms, etc., together with traditional classrooms, constitute an open, interconnected “borderless” learning ecosystem.

3.3. Development requirements: A paradigm revolution in the education system

The connotation and characteristics of new-type talents impose revolutionary demands on the traditional education system. This is not about minor repairs but a comprehensive paradigm reconstruction as outlined:

- (1) Shift in goals, from “Knowledge Transmission” to “Literacy Cultivation”: The goal of education must shift from transmitting the known to inspiring the unknown. Its core task is to develop students’ core competencies and sound character, laying the foundation for their lifelong learning

In summary, new-type talents are both the product and hallmark of the integrated development of education, science and technology, and human resources. Their cultivation urgently requires the education system, driven by the engine of educational technology, to undergo a profound systemic transformation, thereby achieving

the great leap from scaled education to personalized, innovative education.

4. Core pathways for educational technology to promote talent development

Within the dynamic ecosystem of integrated education, science and technology, and human resources, educational technology has transcended its purely instrumental role to become a core driver reshaping the paradigm of talent development. By constructing a new, data-driven, intelligently connected educational ecosystem, it provides systematic solutions for the precise identification, personalized cultivation, scientific evaluation, and efficient allocation of talent. This study proposes the following five core pathways to elucidate the internal mechanisms and practical directions for educational technology to empower talent development.

4.1. Data-driven: Shifting from “Vague Judgment” to “Precise Talent Identification”

Traditional education often relies on single-dimensional metrics like exam scores for student assessment, making it difficult to comprehensively and objectively reveal their intrinsic potential and developmental inclinations. Educational technology, by constructing “learner digital profile” systems, can seamlessly collect multidimensional process data from students regarding knowledge mastery, skill application, learning behaviors, and even social collaboration. Deep analysis using big data and AI algorithms enables precise assessment of an individual’s knowledge structure, cognitive style, strengths, and interests, forming a comprehensive, dynamic personality map. The core value of this pathway lies in “identifying their strengths and matching them appropriately.” It provides a scientific starting point for personalized cultivation, ensuring precision in tailored education from the source and effectively preventing talent from being overlooked.

4.2. Intelligent empowerment: Reshaping the model from “Mass Cultivation” to “Personalized Talent Nurturing”

Building on precise talent identification, educational

technology employs integrated intelligent technologies to customize unique growth plans for each learner. Adaptive learning platforms can plan and adjust personalized learning pathways and resource recommendations in real-time based on a student’s digital profile, truly achieving “one plan per person.” Meanwhile, technologies like Virtual Reality (VR), Augmented Reality (AR), and Digital Twins construct highly realistic immersive practice scenarios, allowing students to tackle real-world complex problems in safe, controlled conditions, significantly enhancing their innovation and practical abilities. Furthermore, cloud-based collaboration platforms and project-based learning tools break physical boundaries, connecting teachers, students, and experts globally, forming cross-cultural, interdisciplinary collaborative innovation networks that directly cultivate the essential collaboration and communication competencies required by future talent.

4.3. Digital profiling: Transforming the paradigm from “Single Score” to “Scientific Talent Evaluation”

To steer talent evaluation back towards a competency-based foundation, educational technology constructs a developmental evaluation system centered on the “comprehensive competency digital profile.” It overcomes the drawbacks of traditional summative evaluation (like high-stakes exams) by shifting towards continuous observation and analysis of the entire learning process. This evaluation mechanism can effectively record and assess students’ growth trajectories in higher-order abilities such as critical thinking, creative problem-solving, and teamwork. This digital profile thus becomes a credible, multidimensional credential of competency, far more comprehensive and equitable in reflecting the true value of talent than a single score. Its purpose is not only assessment but also providing real-time feedback, guiding teachers to optimize instruction and helping students with self-awareness and metacognitive management for proactive personal growth planning.

4.4. Platform connectivity: Linking the ecosystem from “Talent Seeking Positions” to “Efficient Talent Allocation”

The deeper value of educational technology lies in

bridging the gap between talent supply and industry demand. By constructing open talent ecosystem platforms, and under the premise of privacy protection and authorization, a student's "competency digital profile" can serve as an encrypted, trustworthy "digital credential" for intelligent matching with industry innovation projects, R&D needs, and internship opportunities. This pathway greatly enhances the efficiency of talent allocation, enabling enterprises to quickly discover individuals with specific innovative potential and allowing students to connect with real-world challenges earlier. It translates the concept of industry-education integration into precise practice and promotes the efficient realization of talent value in the economic and social sphere.

4.5. Closed-loop feedback: Evolving the ecosystem from "Passive Learning" to "Systemic Talent Motivation"

The aforementioned four pathways do not exist in isolation but collectively form a virtuous cycle system for talent development capable of self-evolution. In this system, every instance of learning, practice, and innovation by talent is recorded, evaluated, and potentially matched with new opportunities. This immediate, positive

feedback creates a powerful incentive effect, continuously stimulating their internal motivation and developmental resilience. More importantly, practical feedback from industry and dynamics from the frontiers of science and technology can flow back rapidly to the education system through the platform, driving the continuous iteration of educational content, methods, and goals. This endows the entire integrated ecosystem of education, science and technology, and human resources with an "adaptive" capacity to dynamically respond to future changes, forming a virtuous development pattern of spiral ascent.

5. Conclusion

In conclusion, educational technology profoundly reconstructs the logic and practice of talent development through a new, full-chain, closed-loop paradigm of "precise identification → empowered nurturing → scientific evaluation → efficient allocation → systemic motivation." These five pathways are interrelated and progressively layered, together providing a fundamental support system for cultivating new-type talents capable of adapting to and leading the future.

Disclosure statement

The authors declare no conflict of interest.

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