# DIGITAL AND GREEN TRANSFORMATION OF VOCATIONAL EDUCATION IN CHINA

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## ABSTRACT
Against the backdrop of the Fourth Industrial Revolution and global climate action, the dual transformation—digital and green—has become a defining imperative for vocational education systems worldwide. China, operating the world's largest vocational education system, has embarked on an ambitious journey to integrate digital technologies and sustainable development principles into its vocational education and training (VET) framework. This article examines the digital and green transformation of vocational education in China from an educational administration perspective. It clarifies core concepts including digital transformation, green skills, and the twin transition, grounding them in socio-technical systems theory, human capital theory, and the UNESCO Education for Sustainable Development framework. The article synthesizes Chinese and international scholarship, identifying convergences, tensions, and gaps, and analyzes implications for educational policy, institutional governance, organizational management, leadership, teachers, and students. It further examines operationalization within Chinese vocational colleges through the National Smart Education Platform, virtual simulation training bases, and green skills curriculum integration. The article concludes that successful dual transformation hinges on coordinated governance, data-driven decision-making, industry-education integration, and the cultivation of digitally fluent and ecologically conscious educators and learners.
**Keywords:** Vocational Education, Digital Transformation, Green Skills, Educational Administration

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# 1. INTRODUCTION

The convergence of the Fourth Industrial Revolution and the global climate emergency has placed unprecedented pressure on education systems to reimagine their purpose and delivery. Vocational education and training (VET), as the primary conduit between education and the labor market, occupies a strategic position in this dual transformation. Digital technologies—artificial intelligence, big data, the Internet of Things, and virtual reality—are reshaping the nature of work, while the transition to a low-carbon economy generates new occupations and demands a workforce equipped with green skills. Their intersection, termed the "twin transition," has become a central policy priority globally (UNESCO-UNEVOC, 2024; OECD, 2025).

China operates the world's largest vocational education system, with approximately 11,000 schools and colleges enrolling over 30 million students (Ministry of Education of China, 2022a). Since the revision of the Vocational Education Law in 2022, China has accelerated VET modernization through digitalization and greening, issuing policy documents including the Notice on Accelerating Key Tasks of Modern Vocational Education System Construction (2023) and the Opinions on Accelerating Educational Digitalization (2025) (Ministry of Education of China, 2023, 2025).

Despite this momentum, significant challenges persist. Digital construction in many institutions remains at an instrumental level, focused on resource storage and display rather than pedagogical innovation and data-driven governance (Research Group of Renmin University of China, 2025). Green skills integration is fragmented across institutions, with uneven implementation and conceptual inconsistency (Cedefop, 2024; OECD, 2025). Moreover, the administrative and governance dimensions of the dual transformation—how institutions are led, resources allocated, performance measured, and stakeholders coordinated—remain underexplored in the academic literature. This article addresses these gaps by examining the digital and green transformation of vocational education in China from an educational administration perspective, encompassing policy frameworks, institutional governance, organizational management, leadership, and the roles of teachers and students. It synthesizes Chinese and international scholarship to clarify how the dual transformation is unfolding in China's VET system and what administrative conditions are necessary for its success.

# 2. CONCEPTS AND THEORETICAL FOUNDATIONS

## 2.1 Digital Transformation in Vocational Education

Digital transformation in education represents a fundamental reconfiguration of educational processes, governance structures, and pedagogical models enabled by digital technologies. In VET, it encompasses digitization of teaching resources, integration of intelligent technologies into practical training, establishment of data-driven governance systems, and cultivation of digital literacy (Wang & Zhang, 2023). The Ministry of Education of China (2023) has articulated this through digital campus benchmark schools, school-based big data centers, and integrated intelligent teaching and management platforms.

Socio-technical systems theory provides a useful lens, positing that technological change cannot be separated from its social and organizational contexts (Trist, 1981). Applied to VET, successful digital implementation requires simultaneous changes in institutional culture, administrative processes, teacher development, and stakeholder relationships—not merely hardware procurement. Many initiatives therefore fall short, addressing the technical dimension while neglecting the socio-administrative one (Chen et al., 2025).

## 2.2 Green Transformation and Green Skills

The green transformation of VET refers to integrating sustainable development principles, environmental awareness, and low-carbon competencies into curricula, pedagogy, institutional operations, and governance. At its core is the concept of green skills, broadly defined as the technical knowledge, values, and attitudes needed to support a sustainable and resource-efficient

society (Cedefop, 2024). The OECD (2025) further emphasizes that green skills encompass both generic sustainability competences applicable across all occupations and specific technical skills required for emerging green sectors such as renewable energy and carbon management.

The European Commission's (2022) GreenComp framework organizes twelve sustainability competences into four areas: embodying sustainability values, embracing complexity, envisioning sustainable futures, and acting for sustainability. This underscores that green transformation is not merely adding environmental content but cultivating holistic knowledge, skills, and values. In China, the "dual carbon" goals—carbon peaking before 2030 and neutrality before 2060—provide the policy framework, with the Ministry of Education (2022b) calling for incorporation of green and low-carbon concepts into the education system.

### 2.3 The Twin Transition: An Integrated Framework

The twin transition recognizes that digitalization and greening are mutually reinforcing transformations requiring integrated attention (UNESCO-UNEVOC, 2024). Digital technologies such as smart grids and AI-driven optimization enable the green transition, while sustainability imperatives drive environmentally responsible digital development. In VET, this demands preparing learners for a digitally mediated and ecologically constrained labor market while transforming institutional operations to be both digitally intelligent and environmentally sustainable.

Human capital theory (Becker, 1964) provides an economic foundation, framing digital and green skills cultivation as strategic investment in labor market competitiveness. However, it prioritizes economic outcomes over social and ecological dimensions. The UNESCO Education for Sustainable Development framework (UNESCO, 2020) complements it by emphasizing education's transformative role in fostering sustainable lifestyles and social equity. Together, these perspectives provide a multi-dimensional foundation for analyzing the digital-green transformation of vocational education.

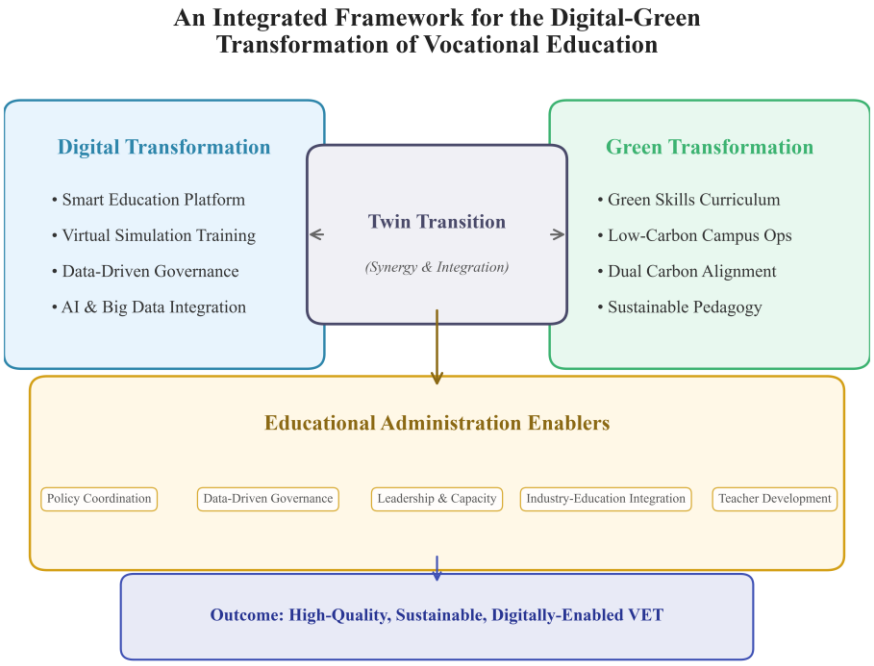



Figure 1. An integrated framework for the digital-green transformation of vocational education.

## 3. REVIEW AND SYNTHESIS OF ACADEMIC LITERATURE

The literature on digital and green transformation of VET has grown rapidly but remains characterized by siloed research traditions with limited cross-fertilization. This section synthesizes key Chinese and international scholarship, identifying connections, tensions, and gaps.

### 3.1 Digital Transformation: From Instrumental Adoption to Systemic Reform

International research has shifted from technology acceptance models toward systemic perspectives examining how digitalization reshapes governance, curriculum, and industry-education relationships. The OECD (2025) notes that digitalization enables new forms of work-based learning, including virtual apprenticeships, while creating challenges related to data privacy and the digital divide. Chinese scholarship is particularly prolific. Wang and Zhang (2023) identify achievements in digital infrastructure and governance frameworks while highlighting challenges in advancing student learning initiative and data-driven management capacity. Li et al. (2025), employing a PMC index model across five provinces, find that policy frameworks are well-designed but implementation effectiveness varies significantly, with western provinces lagging behind eastern coastal areas.

The Research Group of Renmin University of China (2025) argues that the National Smart Education Platform represents a government-led integration model transcending a simple curriculum website, developing into a comprehensive ecosystem. By the end of 2024, it integrated over 7.15 million resources serving more than 23 million users, with daily visits exceeding 35 million. However, the study acknowledges that digital construction in many institutions remains instrumental, and the platform lags in developing intelligent analysis and personalized teaching service functions. Li et al. (2025) further find that implementation effectiveness correlates with regional economic development, suggesting resource allocation and institutional capacity are critical mediating factors.

### 3.2 Green Transformation: Concepts, Integration, and Challenges

A systematic review by Cedefop (2024) finds broad consensus on green skills importance but inconsistent definitions and uneven implementation, identifying tension between generic green competences and occupation-specific technical skills. OECD (2025) research shows nearly one-quarter of young VET graduates work in “green-driven” jobs, underscoring VET's centrality, while highlighting the challenge of engaging SMEs in anticipating green skills needs. UNESCO (2024) reports that over 68% of Member States have introduced green TVET policies, though policy adoption does not guarantee classroom implementation.

Chinese green VET research is growing rapidly, fueled by dual carbon goals. The ILO's (2025) GreenPulse for TVET project developed a Guide on Core Skills for the Green Transition piloted in 110 Chinese vocational institutions, representing a significant international collaboration. UNICEF (2025) reports that a green skills initiative across 13 institutions in six provinces benefited over 20,000 students, demonstrating feasibility and impact. Studies on intelligent construction majors illustrate how specific disciplines integrate sustainability into curriculum design, practical training, and assessment (Atlantis Press, 2025). Despite these advances, Chinese green VET research remains concentrated in engineering and technology fields, with limited attention to service sectors such as tourism, hospitality, and business administration—areas where green transformation is equally imperative but less systematically addressed.

### 3.3 Synthesis: Convergences, Tensions, and Gaps

A key convergence is recognition that both transformations require systemic, institution-wide change rather than isolated interventions, demanding new governance forms and stakeholder collaboration. A significant tension exists between rapid policy formulation and slower institutional implementation, particularly in less developed regions (Li et al., 2025), and between top-down mandates and bottom-up innovation. The most significant gap is the absence of integrated analyses of digital and green transformations as a twin transition, with most studies examining them in isolation. The educational administration perspective—governance, leadership,

management, and policy implementation—also remains underexplored. This article addresses these gaps through an integrated, administration-focused analysis.

# 4. ANALYSIS FROM AN EDUCATIONAL ADMINISTRATION PERSPECTIVE

## 4.1 Educational Policy: Coordination and Alignment

The dual transformation demands high policy coordination across departments. China's 2025 Opinions on Accelerating Educational Digitalization established a cross-departmental mechanism involving education, cyberspace, public security, development and reform, finance, science and technology, industry and information technology, data management, and human resources departments (Ministry of Education of China, 2025), reflecting recognition that digitalization requires coordinated action across infrastructure, funding, security, and industry domains. For green transformation, the Ministry of Education's (2022b) carbon-neutral talent cultivation plan requires alignment with industrial policies, environmental regulations, and labor market standards. The ILO (2025) notes that adding occupations like carbon emissions manager and carbon sink assessor to the National Occupational Classification Catalogue aligns VET qualifications with green labor needs, though occupational standard updating often lags behind industrial transformation, creating a policy-implementation gap that administrative systems must proactively address.

## 4.2 Institutional Governance: Data-Driven Decision-Making

Digital transformation reshapes institutional governance through data-driven decision-making. School-based big data centers and intelligent management platforms (Ministry of Education of China, 2023) enable real-time analysis of learning outcomes, resource utilization, and operations, shifting governance from experience-based to evidence-based. This requires new data governance frameworks and enhanced analytical capacity among leaders (Chen et al., 2025). Shenzhen Polytechnic University's pilot “Chief Digital Official” system exemplifies professionalized digital governance (Shenzhen Polytechnic University, 2025). However, Chen et al. (2025) find that many institutions face inconsistent data standards, limited governance capacity, and faculty resistance to data-driven processes.

## 4.3 Organizational Management and Leadership

The dual transformation requires restructuring organizational forms for agility and cross-departmental collaboration. Traditional bureaucratic structures are ill-suited to rapid digital and industrial change, prompting innovative forms such as industry-education integrated colleges and dual-qualified teacher exchange mechanisms (Research Group of Renmin University of China, 2025). Green transformation adds complexity, requiring dedicated sustainability structures such as carbon management offices and cross-functional coordination. The OECD (2025) emphasizes that organizational change is the most neglected dimension, with institutions investing in technology while failing to adapt management structures.

Leadership is a critical success factor. Institutional leaders must articulate vision, allocate resources, manage change, and foster innovation culture. Shenzhen Polytechnic University demonstrates that leadership training and collective learning are essential for driving digital transformation (Shenzhen Polytechnic University, 2025). However, leadership capacity is unevenly distributed, with many leaders in less developed regions lacking digital literacy and sustainability awareness. The dual transformation requires distributed leadership engaging department heads and teacher leaders, not solely top-level directives.

## 4.4 Teachers and Students: The Human Dimension

Teachers are frontline agents requiring new competences: digital pedagogical skills, green disciplinary knowledge, interdisciplinary teaching capacity, and the ability to facilitate project-based and experiential learning in digitally mediated and sustainability-focused contexts. The Ministry of Education (2023) emphasizes dual-qualified teacher teams—possessing both teaching

expertise and industrial experience—as key to quality enhancement. For students, digital technologies offer personalized learning pathways, virtual simulation training, and access to high-quality resources through platforms such as the National Smart Education Platform, while green skills development enhances employability in emerging green sectors and cultivates ecological citizenship. However, the digital divide—unequal access to technology and digital literacy across regions and socioeconomic groups—threatens to exacerbate educational inequality. The UNICEF (2025) initiative demonstrates that targeted interventions can effectively engage disadvantaged students in green skills development, but scaling such interventions requires sustained administrative commitment, equitable resource allocation, and targeted capacity building for institutions in less developed regions.

# 5. APPLICATION TO THE CHINESE EDUCATIONAL CONTEXT

## 5.1 The National Smart Education Platform

Launched in March 2022 with an international version in 2024, the National Smart Education Platform for Vocational Education is the cornerstone of China's digital transformation (Research Group of Renmin University of China, 2025). Unlike market-driven platforms in some Western contexts, the Chinese platform is characterized by a government-led integration model combining public investment with enterprise participation. By the end of 2024, it had integrated over 7.15 million resources, including professional teaching resource libraries, high-quality online courses, virtual simulation training modules, and teacher development programs, serving more than 23 million users with daily visits exceeding 35 million. Through cooperation with more than 3,000 enterprises, it has synchronized curriculum content with industrial development, shortened core course update cycles to three months, and built a full-process digital system covering resources, teaching, evaluation, and certification. This model reflects China's distinctive approach to educational digitalization—one that leverages the state's coordinating capacity to achieve scale and standardization while engaging industry partners to ensure relevance and quality. It also serves as central infrastructure for data collection, monitoring, and policy implementation across the VET system.

## 5.2 Virtual Simulation Training Bases

The Ministry of Education (2023) plans to establish approximately 200 virtual simulation training bases by 2025, addressing the high cost, safety risks, and environmental impact of traditional hands-on training. In the green transition context, virtual simulation enables students to practice renewable energy installation, energy-efficient retrofitting, and carbon monitoring in risk-free, cost-effective environments. Integrating virtual with physical facilities creates a “virtual-real integrated teaching ecology” enhancing outcomes while reducing environmental footprint (Luo, 2024), aligning with socio-technical systems theory through combined technological, pedagogical, and infrastructural innovation.

## 5.3 Green Skills Curriculum Integration

The Ministry of Education's (2022b) directive to incorporate green concepts has been operationalized through new majors in carbon emissions management and new energy technology, and revision of existing majors such as intelligent construction and automotive engineering (Atlantis Press, 2025; State Council of China, 2025). The ILO's GreenPulse project Guide on Core Skills for the Green Transition, piloted in 110 institutions, integrates generic green core skills with occupation-specific technical skills (ILO, 2025), demonstrating adaptation of international frameworks to the Chinese context.

## 5.4 Industry-Education Integration: The Administrative Backbone

The revised Vocational Education Law (2022) legally mandates deep industry-education cooperation, establishing joint curriculum development, shared facilities, and dual-qualified teacher exchange. In the digital domain, industry partners provide cutting-edge technologies and real-world data; in the green domain, they offer insights into emerging green occupations and

sustainable production. The 2022 “Special Training Programme for On-Site Engineers” exemplifies this model, encouraging institutions and leading enterprises in advanced manufacturing, new energy, and AI to jointly develop project-based programs integrating digital and green principles (Ministry of Education of China, 2022a). This reflects China's distinctive administrative approach combining state coordination, market dynamism, and institutional collaboration.

## 6. CONCLUSION

This article has examined the digital and green transformation of vocational education in China from an educational administration perspective, addressing gaps where digitalization and greening are often studied in isolation and administrative dimensions overlooked. The analysis reveals that the dual transformation is a complex process encompassing policy coordination, institutional governance, organizational restructuring, leadership development, teacher capacity building, and student engagement.

Conceptually, the article proposes an integrated framework for the twin transition grounded in socio-technical systems theory, human capital theory, and the UNESCO ESD framework. Empirically, it synthesizes Chinese and international scholarship and examines operationalization through the National Smart Education Platform, virtual simulation bases, green skills curriculum integration, and industry-education integration. China's government-led, scale-oriented approach offers advantages in rapid system-wide transformation, though challenges remain in uneven regional implementation, policy-practice gaps, and limited data governance capacity.

From an administrative perspective, success hinges on coordinated cross-departmental governance aligning digital and green objectives; data-driven decision-making supported by robust data frameworks; agile organizational structures facilitating collaboration; visionary leadership; sustained teacher professional development; and targeted interventions ensuring equitable benefit distribution. As China advances toward a digitally intelligent and ecologically sustainable VET system, the integrated administrative framework proposed here provides a foundation for future research, policy, and practice in China and comparable contexts worldwide.

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