

## ORIGINAL ARTICLE

# The digital transformation of vocational education: Experience and reflections of Shenzhen Polytechnic University

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## ABSTRACT

Promoting digital transformation is a vital change to achieve the high-quality development of vocational education and help build China into a leading country in education. Shenzhen Polytechnic University (SZPU) promotes digital transformation from the perspectives of critical layout, operational order, and infrastructure development. SZPU emphasizes the leading role of “humans” in digital transformation by strengthening the digital empowerment of administrators, teachers, and students and highlights the central position of digital teaching transformation from aspects such as teaching concepts and models, curricula and resources, teaching methods and means, and teaching management and evaluation. Engaged in the research and development (R & D) of digital technology, digital technology applications, and digital social services, SZPU is devoted to mutual facilitation between R & D services and digital transformation. Building platforms, promoting the “going global” of vocational education, and creating digital practical teaching brands make international exchanges and cooperation an essential extension of the digital transformation of vocational education. The digital transformation of vocational education is a “progressive transformation” from educational empowerment to educational reconstruction, a “creative transformation” from focusing on technology to highlighting thinking, a “human-oriented transformation” from emphasizing design to highlighting experience, a “participatory transformation” from technological application to technological R & D, and a “collaborative transformation” from focusing on a single perspective to benefiting the whole. Digital transformation is a fundamental process to achieve digital governance of vocational education, deepen education and teaching reforms, and modernize vocational education in the era of the digital economy, with important implications for improving the quality of education and teaching and promoting economic and social development.

**Key words:** vocational education, digital transformation, educational empowerment, high-quality development

## INTRODUCTION

The swift advancement of digital technology has spurred a global educational shift, especially in vocational education, characterized by a paradigm transformation and a marked digital evolution.<sup>[1–5]</sup> Internationally, the

United Nations Educational, Scientific and Cultural Organization (UNESCO) published the *Beijing Consensus on Artificial Intelligence and Education* in 2019, the European Union (EU) issued the *Digital Education Action Plan (2021–2027)* and the *2030 Digital Compass: the European way for the Digital Decade*, and the Organization for

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Economic Cooperation and Development (OECD) published the *Digital Education Outlook* in 2021. Other countries and regions have also issued policies and plans to advance the digital transformation of education. In China, the report to the 20th National Congress of the Communist Party of China proposes to promote the digitalization of education and build a society and country of learning where lifelong learning is pursued by all. The *Key Priorities of the Ministry of Education in 2022* proposes to “implement the strategic action of education digitization”; some other documents also propose arrangements and requirements for the digital transformation of education. These framework documents provide the necessary affirmation and feasible policy support for the comprehensive digital transformation of education and justify such transformation from a broad perspective of educational development.

Many universities are developing specific digital strategies in response to the massive shift toward using new technology.<sup>[6–8]</sup> However, there is a lack of clear understanding regarding the fundamental issue of “what and how to transfer” in the digital transformation of education, and research and practice in this regard have yet to go deep.<sup>[9]</sup> Vocational education is no exception.

There are some common issues. The first issue lies in the concept of education. “At present, the digital transformation of vocational education in China is faced with cognitive misunderstanding or even errors”.<sup>[10]</sup> In the process of digital transformation, there may be path dependence within the education system. The original teaching model, paradigm of knowledge production, management concept, and the cultural system still play a role.<sup>[11]</sup> The second issue concerns subject literacy. For front-line teachers, “their workload increases due to the lack of information literacy, which leads to difficulties in curriculum design, learning evaluation, and classroom supervision”.<sup>[12]</sup> In addition, faculty resistance to digital transformation also hinders change management.<sup>[13]</sup> The third is the issue of equilibrium. “Currently, there are serious gaps in the development of information infrastructure and digital educational resources worldwide, and coronavirus disease 2019 (COVID-19) has further highlighted the unbalanced development of education caused by digital divides”.<sup>[14,15]</sup>

The fourth issue concerns hardware support. Some educational institutions are largely deterred by the heavy funding investment necessary to develop digital infrastructure and intelligent systems. In addition to these common issues, educational institutions have individual problems and different logical origins regarding digital transformation, further increasing the complexity of educational digital transformation. Focusing on the practice and exploration of Shenzhen

Polytechnic University (SZPU) in promoting digital transformation, this paper studies and analyzes the theoretical logic behind the digital transformation of vocational education and seeks to provide a reference for promoting digital transformation in vocational education and even higher education.

## PRACTICAL EXPERIENCE OF DIGITAL TRANSFORMATION AT SZPU

To meet the needs of digital economic development and keep up with the development trend of digital technology, SZPU has been actively engaged in theoretical research and practical exploration of digital transformation. The university issued the *Digital Transformation Action Plan*, strengthened top-level design, and introduced a package of measures in overall design, subject empowerment, talent training, technology research and development (R & D), and external exchanges to promote digital transformation as a critical engine propelling high-quality development.

### **Comprehensively advancing digital transformation design**

*Promoting the digital transformation of major layout*  
Vocational education has close ties with industry. Regional industries’ digital, intelligent, and green transformation and their development toward the higher end inevitably require the digital transformation and upgrading of majors. To enhance the integration of education, technology, talent, industry, and innovation chains, SZPU has built a big data platform for industry and education integration, carried out extensive data analysis on industrial development, and tracked and improved the timeliness, accuracy, and convenience of the industrial frontier through digital means. Focusing on the structures of regional strategic industries, development of key technologies, new requirements of talent development and ecological civilization, and new developments in the digital economy, SZPU has developed the major pedigree diagram and dynamic job demand model for industry–education integration, sought alignment between majors and industries and between curricula and posts, and facilitated accurate matchmaking between the supply side of vocational education and the demand side of industries. On this basis, it has promoted the digital transformation of majors in three aspects. The first aspect is the development of new majors (directions). Focusing on manufacturing, finance, communications, and international trade, SZPU has introduced new majors, such as artificial intelligence (AI) technology, industrial internet, blockchain, fintech, communication software, cross-border e-commerce, and new directions in digital technology.

The second aspect is establishing pilot interdisciplinary majors. Digital industrialization and industrial digitization have expedited the penetration and integration of different technical fields, giving birth to new disciplines and majors. Relying on the Cross-school Innovation Center, SZPU has promoted the multi-factor coupling of major modules in a project-driven manner and set up emerging interdisciplinary majors such as “AI + art design”, “AI + financial management”, and “AI + digital animation”.

The third aspect is the digital transformation of traditional majors. SZPU fully taps into the strong momentum of cloud computing, big data, Internet of Things (IoT), and other technologies. Furthermore, it promotes creation through the coupling between new technologies and traditional majors and revitalizes traditional majors by adapting them to the needs of digital economic development.

#### *Promoting the digital transformation of operation order*

Digital empowerment has dramatically optimized the operational order of educational institutions, and its functions of “personal substitution” and “personification” have substantially enhanced the operational efficiency of educational institutions by emancipating the workforce and streamlining the business process. Adhering to the demand-oriented approach, SZPU aims to improve the “user experience” and design management and services in an integrated manner. According to the design plan, SZPU focuses on promoting online business handling in the initial stage of the digital transformation of operational order to link the data of different business systems, break down barriers, and achieve data unification, data concentration, and “unified online handling.” The university has established an integrated digital information system platform, and 96.6% of business requests are processed on the “unified online handling” platform. The “iSZPU” application (APP) has recorded 61,000 registered users, providing mobile and intelligent management services. In the middle stage of the digital transformation of the operation order, SZPU focuses on reconstructing the business process and operational order, which leads to the gradual optimization and reorganization of the university structure. There is increasing coordination among departments with their business overlapped, interlaced, and streamlined, which collaborate to promote “one-time handling” of business. An interconnected big data center has been established, with the operation status fully connected to the unified control center, achieving “a grasp of the whole situation on a single map”. In the advanced stage of the digital transformation of operation order, SZPU will achieve automatic services and management enabled by a greater

volume of unified big data and a more scientific, intelligent analysis model.

#### *Promote the development of digital infrastructure*

The development of digital infrastructure provides the information carrier and material support for promoting digital transformation. It determines the quality, level, and capability of education digitization services to a certain extent. It mainly includes “various digital equipment, networks, terminals, software and hardware platforms, systems, sites, tools, software, data, resources, systems, and mechanisms that support public education and school teaching”.<sup>[6]</sup> With a long-term vision and considering the benefits, SZPU has comprehensively promoted the development of campus digital infrastructure according to the idea of building, retrofitting, and eliminating a batch of infrastructure facilities.

First, SZPU continues to promote infrastructure evolution and upgrading. It has built a new-generation campus network, established an intelligent, three-dimensional campus security system, and created a safe and comfortable digital environment for education and teaching that features integration, innovation, diversification, and sharing. At present, the total egress bandwidth of the campus network is 14.5 gigabyte (GB), and that of the wireless network is 8.0 GB. The outdoor coverage rate of 5G networks is 100%, and the university’s operational status is fully connected to the control center. For this outstanding performance, SZPU has been rated as the “Campus for 5G Demonstration Application” by the Ministry of Industry and Information Technology.

Second, SZPU attaches great importance to digital security and strengthens network security management. It has established and improved the mechanisms of data sharing and opening, development and utilization, security supervision and management, and strengthened publicity and education on network and information security, thus effectively preventing network security risks and protecting personal privacy. In addition, it has strengthened capacity building for network security assurance, regularly carried out network attack and defense drills, compliance evaluation, risk assessment, and potential risk identification, and has comprehensively enhanced the effectiveness of network security monitoring, interception, and early warning.

#### ***Emphasizing the leading role of “humans” in digital transformation***

All actions in the digital transformation of education must ultimately be implemented by the educational subjects. Based on the concept of inter-subjectivity, SZPU comprehensively promotes the digital

empowerment of “humans” from the dimensions of administrators, teachers, and students.

### *Strengthening the digital empowerment of administrators*

Positive “behavioral hints” from peers can affect the cognition and practice of latecomers to a certain extent. To break the long-term fixed teaching paradigm, SZPU has first strengthened the digital empowerment of its administrators by engaging all teachers and students to participate in “digital action”. It has promoted the digital literacy of university leadership. University leadership is at the top of SZPU’s decision-making organization and critically impacts SZPU’s digital transformation. By organizing training, workshops, and collective learning, SZPU provides opportunities for university leaders to gain advanced experience at home and abroad to break through their limitations and lead the formulation of university-based digital transformation plans suitable for SZPU. SZPU has also implemented the pilot “Chief Digital Official” system. It has introduced high-level experts in digitalization to form an ecological expert team with on-campus experts and has promoted the pilot digital transformation of relevant teaching units through the cooperation of expert teams with different professional backgrounds, research specialties, and fields of practice. In addition, SZPU prioritizes the training on and learning of emerging digital leadership skills among middle-level officials. It has set up special training programs on “digital leadership improvement”, such as training courses for vice deans of teaching and directors of majors, vigorously improving the digital insight, decision-making, and execution of the official team.

### *Strengthening the digital empowerment of front-line teachers*

SZPU has strengthened the theoretical research on teachers’ digital literacy, thoroughly analyzed the *Digital Literacy Global Framework* and *ICT Competency Framework for Teachers* of UNESCO and the *Teachers’ Digital Literacy* issued by the Ministry of Education and established a teacher digital empowerment system characterized by “guidance of standards, multidimensional empowerment, certificate evaluation, and continuous improvement”.

First, SZPU draws on the teachers’ digital capability frameworks of world-leading universities to develop a university-based teachers’ digital capability model from six dimensions: digital content creation, digital resource development, digital teaching, digital communication and collaboration, digital evaluation, and digital security, thus reconstructing the teachers’ capability structure in the digital era.

Second, SZPU strengthens the digital empowerment of teachers from multiple dimensions. It implements

classified, layered, and phased full-cycle training based on the characteristics and actual needs of different teachers, establishes various teaching and academic communities such as cross-university virtual teaching and research offices, cross-school teaching and research offices, and professional teaching and research offices, and carries out activities such as digital teaching and research academic salons and expert workshops to improve teachers’ digital teaching concepts and capabilities.

Third, SZPU has developed the teachers’ digital capability evaluation system and “micro-certificate”. It has developed a classified teachers’ digital capability evaluation system based on majors with strong and weak correlations to digital technology, age groups of teachers, and position characteristics to evaluate teachers’ digital literacy by modules and grades and promote their self-improvement in digital empowerment.

### *Strengthening the digital empowerment of students*

SZPU has established the students’ digital literacy framework. It cultivates students’ general literacy, enhancing their ability to correctly perceive, collect, and acquire digital information. It fosters students’ innovative literacy, enhancing their data exchange and communication ability, data analysis and evaluation, and digital security protection. It cultivates students’ interdisciplinary literacy, improving their ability to solve digital problems and shape digital morality and values. In addition, SZPU has developed general education courses on digital literacy. It has collaborated with digital technology experts from domestic and foreign universities, research institutes, and industry enterprises to create digital literacy general education courses to popularize digital technologies, such as AI, big data, 5G, and blockchain.

Relying on student associations, off-campus practice bases, and innovation and entrepreneurship bases for college students, it has developed a series of digital literacy practical courses geared toward actual production. These courses highlight ideological and political construction and the development of a digital China, showcasing China’s new achievements in digital economic development. Furthermore, SZPU has developed the students’ digital literacy evaluation standards and certificates. Based on internationally recognized and world-leading skill certification standards in computer and digital application software, SZPU has developed a graded (junior, intermediate, and advanced) students’ digital literacy evaluation index system with university characteristics, as well as the certificate of students’ digital skill level and curriculum package up to international standards, providing an authoritative evaluation standard and methodology for students’ digital literacy. The university has also strengthened



digital ethics education to improve students' awareness of and response to digital ethics.

### **Highlighting the central position of digital teaching transformation**

#### *Promoting the digital transformation of concepts and models*

New requirements have been put forward for labor skills in the new era, namely “mastering core skills and enhancing adaptability, improving soft skills and comprehensive abilities, and expanding the breadth and depth of hard skills mastery”.<sup>[17]</sup> To meet the development requirements of technical and skilled talents in the digital era, SZPU has innovated the concept of talent cultivation, integrated digital technology and literacy into its cultivation objectives, and promoted higher-level knowledge learning, skills training, and thinking development in the context of digital empowerment of students. According to the characteristics of different majors and corresponding occupations, the content about digital capabilities and knowledge in the talent cultivation program has been refined. Seizing the trend of digital industrialization, industrial digitization, and benchmarking against regional strategic emerging industry clusters, it has developed a group of professional teaching standards that adapt to industrial transformation and upgrading. In terms of the talent cultivation model, SZPU follows the type orientation of vocational education, adheres to the guiding role of practice, and relies on technical means such as digital twin, virtual reality (VR), and holographic projection to enrich, improve, and innovate the characteristic teaching model of vocational education that is driven by technology, supported by products, guided by capabilities, and integrates theory and practice to improve the quality of technical and skilled talent cultivation continuously.

#### *Promoting the digital transformation of curricula and resources*

SZPU has proposed the innovative concept of “one book, one course, and one space” to integrate the digital transformation of curricula, teaching materials, and teaching resource platforms. Regarding curriculum development, the university has worked with industry leaders to develop cutting-edge digital technology courses around mainstream digital technologies in the market and has organized on-campus and off-campus experts to jointly create professional courses with domestic and international influence. In terms of the digital transformation of curriculum content, SZPU reconstructs the knowledge graph, curriculum system, and curriculum content based on the logical relationship between knowledge points and restructures the coupling between traditional curriculum content and cutting-edge professional knowledge and digital technology according

to the digital transformation trends of industries related to specific majors (clusters) and the new knowledge and skill standards of related post groups. Regarding the digital transformation of the presentation model, “traditional forms of educational content presentation mainly involve description, with the main encoding and decoding methods being text and language, supplemented by charts and videos”.<sup>[18]</sup>

To optimize content presentation, SZPU actively promotes the application of VR and other technological means and helps students accurately perceive the original state of things by simulating actual scenes with digital technology. For example, regarding “construction technology,” a national high-quality online course in vocational education comprehensively promotes digital transformation based on the teaching concept of integration of physical and digital worlds and coexistence of virtuality and reality. It enables the digitalization and virtual simulation of real-world teaching situations and teaching resources by fully leveraging technologies such as big data and extended reality (XR). The course has developed 66 VR and 113 augmented reality (AR) resources that present self-learning tasks to students, allowing them to deepen their understanding of the course content in an immersive way. Furthermore, the teaching process is recorded on the massive open online courses (MOOC) platform, in which task results are recorded on the blockchain, enabling the traceability of course data and facilitating the process-based evaluation of course implementation and targeted reflection on teaching.

Regarding resource development, SZPU has standardized the development standards for digital teaching resources and created a “platform + ecosystem” resource supply system and a collaborative and shared application environment. Combining the characteristics and needs of different majors, the university has developed massive digital teaching resources integrating multiple media to meet the needs of online and offline mixed teaching. In resource development, SZPU emphasizes the awareness of intellectual property rights (IPR) protection and highlights the independent creativity, construction, and development of teaching resources by introducing external technology and personnel.

Meanwhile, it also emphasizes the participation of students and encourages teachers to solicit student opinions widely and develop resources based on students' thinking, habits, and preferences, thus ensuring the “experience-friendliness” of resources. In terms of the development of teaching materials, SZPU vigorously promotes the digitization reform of teaching materials and has developed new forms of digital teaching materials. It formulated the *Management Measures for the*

*Development of Digital Teaching Materials* and established relevant standards, considering the particularity of ideological and political construction to improve the ideological and scientific levels of digital teaching materials.

### *Promoting the digital transformation of teaching methods and means*

#### Introduce an innovative teaching model

SZPU comprehensively popularized online and offline mixed teaching, flipped classrooms, theory-practice integrated teaching, and other teaching methods, deepens the application of teaching means enabled by digital technology, and creates a learner-centered teaching model with man-machine in-depth coordination. It carries out deep learning oriented to real-world situations with robust technical support, strengthening the practicality, productivity, and social nature of learning.

#### Institute personalized teaching

SZPU has developed digital portraits of students and strengthened big data analysis of students' learning performance. Curriculum programs are customized based on the analysis of the learners. Based on the full availability of existing resources such as teachers, courses, and venues, SZPU explores personalized cultivation based on "one person, one schedule" and has developed an adaptive learning system. It collects students' behavioral data in the learning process. It customizes learning strategies and promotes students' learning content according to their learning progress and characteristics, thus improving their self-learning ability and effectiveness.

#### Create a digital teaching environment

SZPU has created a digital teaching environment featuring three-dimensional demonstration, immersive experience, and interactive learning and has established the XR experience space, Science, Technology, Engineering, Arts, and Mathematics (STEAM) innovation laboratory, and online virtual laboratory (eLab). For high-risk, high-cost, and less visible training procedures in machinery, architecture, and medicine, SZPU has collaborated with enterprises to develop virtual simulation training projects, enabling remote configuration and operation experience of complex work scenarios.

### *Promoting the digital transformation of teaching management and evaluation*

Regarding teaching management, SZPU has built a "teaching command center" and leveraged big data and various cloud teaching platforms to promote data-supported intelligent decision-making<sup>[19]</sup> and change the traditional "empirical decision-making" model.

Regarding teaching evaluation, the *Overall Plan for Deepening Education Evaluation Reform in the New Era* states that "information technology should be fully utilized to make education evaluation more scientific, professional, and objective".<sup>[20]</sup> To overcome the limitations of traditional education evaluation, which often takes a specific moment as the norm or a specific aspect as the entirety, SZPU established an interdisciplinary R & D team and developed an intelligent classroom learning evaluation system guided by the values of refining outcome evaluation, strengthening process evaluation, exploring value-added evaluation, and improving comprehensive evaluation. Based on big data and other technical means, it comprehensively records students' learning processes, depicts their learning trajectories, and creates "portraits" for their personal growth. Based on calculation modeling and other intelligent analysis methods, it actively explores an "integrated" evaluation model that combines knowledge and skill mastery, development of deep learning ability, and emotional experience evaluation to enable the full-process recording of students' learning trajectories, independent control of their learning processes, and automatic evaluation of their learning outcomes.

### ***Enhancing mutual facilitation between R & D services and digital transformation***

Scientific and technological R & D is the source of digital technology innovation and development, and the benefits of digital technology should be utilized to serve society. SZPU has been actively engaged in organized R & D and technical services and has established a digital technology R & D and service platform system with the School of Artificial Intelligence as the "master machine", the research management department as the "pivot", relevant research institutes as the "robotic arm", and industry training colleges and community colleges as the "converter".

#### *Carrying out digital technology R & D*

Digital technology R & D and applications promote each other, an essential mechanism to ensure that universities and colleges better understand the principles of digital technology and the connotation and potential of the digital transformation of education. Focusing on breakthroughs in core generic technologies and application demands in the digital economy, SZPU has launched a group of projects on the basic research of digital technology. The projects aim to advance big data, cloud computing, and AI technologies, improve computing power, and upgrade algorithms. The university is also developing 5G and sensor-based IoT technologies to support the Internet of Everything (IoE). By promoting the cross-integration of digital technologies, the university has opened new innovation tracks.

In the meantime, focusing on strategic needs and the development demands of national and local new infrastructure projects, SZPU has established enterprise directories and technology product lists to enhance innovation and introduce university-based system solutions. For instance, teachers from the Institute of Marine Biomedicine actively participate in Huawei's research projects, helping resolve technological bottlenecks in 5G base construction and providing technological reserves for developing next-generation high-frequency communication equipment.

#### *Carrying out R & D for digital technology applications*

SZPU has strengthened research on industrial digital transformation, promoted changes in traditional industries enabled by modern digital information, advanced internet and AI technologies, and advanced industrial digital transformation through industrial model changing, industrial organization innovation, industrial ecological operation, and industrial system restructuring. SZPU has strengthened the conversion of digital technology applications and implemented the unique action of “digital empowerment for micro, small, and medium-sized enterprises (MSMEs)”. Focusing on digitalization and intelligence, it provides comprehensive digital development evaluation and diagnosis services and intelligent and digital transformation solutions for MSMEs, urges them to establish digital thinking and accelerate online marketing, remote collaboration, digital office services, intelligent production lines, and other applications, and promotes the digital transformation of R & D and design, production and processing, operation and management, marketing, and other businesses of MSMEs.

#### *Providing digital social services*

SZPU leverages its advantage in social training, emphasizes the spillover benefits of digital research results, and comprehensively provides social training in digital skills. It has established lifelong learning service platforms of various forms, such as the Digital University, developed a group of large-scale online open courses, built modular online courses in collaboration with enterprises, and created an abundance of online university resource catalogs and maps, providing high-quality, balanced, diverse, and convenient learning support for citizens. In addition, it has strengthened the diversified supply of digital skills training. For in-service workers, training in big data analysis, software programming, and engineering software is provided to continuously improve their adaptability to posts under new circumstances. For newly employed and re-employed workers, enhanced digital skills training is offered to increase their employability in the digital era. For teachers engaged in vocational education, training in

digital literacy and teaching abilities is offered to facilitate their role transformation. For the elderly, the disabled, and other special groups, public welfare training in digital technology is offered to promote balanced and inclusive development empowered by digital technology.

#### ***Making international exchanges and cooperation an important extension of digital transformation***

##### *Building international exchange and cooperation platforms*

To participate in the global governance of education digitization and grasp the discourse of educational digital transformation, SZPU holds the Belt and Road International Conference on Technical and Vocational Education and Training (TVET) every year. With four editions held so far, the conference facilitates collaboration in theoretical and empirical research on the digital transformation of international vocational education. It establishes a research hub for the digital transformation of vocational education with international influence. In 2023, the UNESCO Chair in TVET Digitalization was launched at SZPU. Relying on the Chair, SZPU has conducted extensive university–enterprise cooperation, South–South cooperation, and multilateral cooperation to promote the digital transformation and development of vocational education worldwide, especially in developing countries and countries involved in the Belt and Road Initiative. UNESCO-UNEVOC and the World Federation of Colleges and Polytechnics (WFCP) Affinity Group in Teacher Professional Development have also settled in the university. These international platforms have effectively promoted international exchanges and cooperation in the digital transformation of vocational education.

##### *Promoting the “going global” of China’s vocational education*

Based on the principles of extensive consultation, joint contribution, and shared benefits, SZPU is committed to strengthening the output of China’s wisdom in vocational education and contributing to the community with a shared future for humankind and sustainable economic and social development worldwide. The university has taken the lead in developing and promoting the “Shenzhen Protocol” for international certification of vocational education. With digital transformation at the core of professional standards, curriculum, and practical training standards, it has developed a series of vocational education standards with digital characteristics, promoting the “going global” of Chinese vocational education standards. SZPU has established nine overseas vocational education and training centers in seven countries, including Germany,



Brazil, Belarus, Malaysia, Bulgaria, Ukraine, and Finland. It is one of the first institutions carrying out the Future of Africa—Sino-African Vocational Education Cooperation Program for the joint training of applied talents in China and Africa. The university has also launched the “Chinese + vocational skills” training program, involving 200,000 participants. In collaboration with enterprises, it has provided 5G communication training for 2288 personnel from countries involved in the Belt and Road Initiative. The university’s international vocational training and cooperation efforts cover 50% of the countries along the Belt and Road.

### *Creating international brands in practical digital teaching*

SZPU has strengthened the practical characteristics of vocational education. Relying on technologies like virtual simulation and digital twins, it has established an international digital research and learning platform in vocational education,<sup>[21]</sup> which features “cloud-based learning, field practice, and strong interaction”. This platform brings together and optimizes the allocation of various resources to create systematic research and learning solutions, presenting a one-stop approach to meeting the online research and learning needs of international and domestic users. Leveraging its advantages in training concepts, models, faculty resources, equipment, sites, and scenarios, the university has built a comprehensive digital training management platform, categorized training platforms by modules, such as industry, profession, and post competency, and created a comprehensive training system that covers a broad selection of industries and job skills and serves a wide range of people. SZPU has also developed characteristic training scenarios, training projects, and entrepreneurial projects. The functions, characteristics, and advantages of different training projects are presented through pictures, texts, and VR videos. The use of virtual simulation technology enables overseas students to receive training remotely.

## **REFLECTION ON THE DIGITAL TRANSFORMATION OF VOCATIONAL EDUCATION**

Based on practical exploration, promoting the digital transformation of vocational education entails in-depth theoretical reflection and research, including reflecting on its “intended state” and “intended pathway”. Only through such reflection can the digital transformation of vocational education be carried out steadily, orderly, and efficiently. Based on the case study of SZPU, the authors particularly emphasize the features outlined in the following sections.

### ***Promoting the “progressive transformation” from educational empowerment to educational reconstruction***

According to the definition, the digital transformation of vocational education is “the comprehensive integration of digital technology into the entire vocational education system under certain norms”.<sup>[22]</sup> This transformation further “leads to profound and systematic changes in the governance modes, architecture, operational mechanisms, pedagogical models, and evaluation standards of vocational education”.<sup>[10]</sup> This indicates that the digital transformation of vocational education is a disruptive process of reconstruction. “Digital transformation should not be confined to the instrumental application of digital technology or trivial adjustments. Instead, it should be taken as an opportunity for overall system change.”<sup>[23]</sup> However, restricted by the law of procedural development of things, the digital transformation of education cannot be achieved overnight. It may involve three phases: “empowering education, innovating education, and reshaping education”.<sup>[24]</sup> Therefore, it is necessary to adhere to the concept of transforming from empowerment to reconstruction and promote progressive transformation in an all-round way.

In practice, we should first advocate connectivity and sharing based on local conditions. The application of digital technology greatly enhances the accessibility of vocational education resources. However, due to the vast territory and significant differences in regional economic development in China, there is a prominent disparity in the distribution of educational resources. In underdeveloped regions, we should take advantage of digital transformation to realize “connectivity and sharing” in education with developed regions, thus promoting equal access to education and improving vocational education and talent cultivation. In addition, we should take a realistic approach to consolidating the foundation.

To promote the digital transformation of vocational education, we should take full advantage of digital technology to solve the practical issues facing vocational education. In addition, we should contemplate fundamental questions related to vocational education. For example, what kinds of educational concepts, values, objectives, systems, methods, and forms should we establish or develop in the digital era? What are the core competency requirements for talents in the digital age? It is also necessary to explore ways to strengthen the inherent attributes of vocational education, reverse the long-existing traditional thinking and tendency of utilitarianism in society and change the weak position of vocational education, thus shaping a new educational ecosystem and contributing to a modern education



system.

### **Promoting “creative transformation” from a focus on technology to an emphasis on thinking**

Technology is objective. The key to the digital transformation of vocational education lies in integrating, applying, and creating technology and maximizing technological empowerment. However, digital transformation is a complex system engineering that requires coordination among many factors, such as technology, personnel, resources, and related policies. Unlike many sectors that focus on “things”, education mainly concerns people-to-people bonds, and its digital transformation primarily involves the digitalization of “humans”. Only with human participation and application can digital technology achieve its maximum benefits, and only educators and students with digital literacy can better apply digital technology, unleash the potential of digital education, and enable the innovative, personalized, and high-quality development of education. Particularly with the rising popularity of AI applications like ChatGPT, non-machine elements, such as digital competence, innovative thinking, and a sense of responsibility, should be the focal points of education.

#### *We should strengthen capacity building for the digital era*

The process of digital transformation in vocational education affecting humans should be one with changes in thinking and behavior brought about using technological tools, which are then applied to education and teaching. Digital capabilities equip individuals to effectively navigate the demands of living, learning, and working within a digitally-driven society.<sup>[25]</sup> Enhancing the development of “digital humans” involves internalizing the application of technology into a shift in human thinking to enhance digital literacy, make “digital” a part of humans, and cultivate modern “digital humans.” It is necessary to reconstruct digital factors and integrate them into human literacy rather than simply adding a “digital kit” to humans.

#### *We should promote the digital transformation of vocational education scenarios*

The digital era should be an era of coevolution between humans and technology, where technology and humans coexist and thrive together. Digital transformation empowers education through technology. However, it should be recognized that the essence of digital transformation in vocational education is not primarily in technological innovation, but in shaping a new generation that conforms to the shared values, order, and civilized norms of human society. Emphasis should be placed on emotional education and innovative

thinking that is more consistent with human attributes. Education and teaching should provide nurturing places and practical activities that help humans adapt to the digital era, thus achieving the digitalization of humans in educational scenarios. In addition to these educational goals, higher vocational institutions also play a crucial role in imparting knowledge and competencies and forecasting the needs of the industrial and economic complex within the context of the digital economy’s evolution.<sup>[26–29]</sup>

### **Promoting “human-oriented transformation” from emphasizing design to highlighting experience**

The shift from focusing on “teaching” to focusing on “learning” marks a considerable improvement in education. The concept of “students” is complex, encompassing both the “category” dimension (all students) and the “group” dimension (*e.g.*, vocational education students), as well as the individual dimension (each individual). The innate endowments, existing foundations, thinking patterns, development interests, and learning habits of students are further amplified today with an emphasis on the “individual value of students”; the educational thinking of the past “industrial era” is clearly outdated. Personalized and customized education, consistent with the learning characteristics of individuals and facilitating a pleasant learning process, has become a reality with the support of digital technology.

#### *We should enhance the sense of gain in digital teaching*

In the digital era, people’s learning time and learning space have expanded. Digital technology can help create an interactive learning environment where online discussions, virtual experiments, and simulations are employed to stimulate interest in learning, promote exchanges and cooperation, and improve the depth and breadth of learning. However, the ways of learning, the accessibility of knowledge, and the subjects’ learning experiences can vary. In practical training in vocational education, when faced with the same training project, machine, and learning task, some people may quickly find solutions, while others struggle to start. Therefore, it is crucial to design digital teaching resources based on students’ emotions, values, and preferences and promote the digital transformation of vocational education.

#### *We should expand the educational functions of digital technology*

The digitalization of education should not be merely a formalized reform of “education + digitalization (technology)” but should reinforce data empowerment and enhance the effectiveness of teaching and education. It should better serve the essence of education and

promote people's free and all-round development through innovation in concepts, forms, and methods. Therefore, the task of digital transformation in vocational education is to explore solutions to practical problems that hinder the innovative development of education by leveraging the advantages and characteristics of digital technology and following the laws of education and physical and mental development. By doing so, we can make digital technology a driving force for educational reform and education and teaching, and give play to the value-added effect of digital education.

### **Promoting “participatory transformation” from technological application to technological R & D**

In the context of the digital economy, digital technology itself is an industry and a productive force. “Digital” serves as both the means and the content of school education and teaching. The cutting-edge nature and frequent iterations of digital technology require educational subjects to have a precise, in-depth, and systematic understanding of digital technology and to pursue a scientific and efficient integration of digital technology into teaching. Only by participating in digital technology R & D, being involved in and having a deep understanding of the front end can we better grasp cutting-edge digital technology and apply it to education, thus improving the quality and effect of education.

### *We should focus on the reality of the digital technology industry*

Due to vocational education's “proximity to industry,” the digital transformation of vocational education should not focus on education itself. Still, it should consider the transformation from an industrial point of view. The digital economy has caused significant changes in the industrial structure and the job market. Machines have done a lot of repetitive work, and some traditional positions have gradually scaled down or even disappeared. On the other hand, the demand for employees in digital technology-related fields has surged, which has given rise to new professional and technical occupations such as AI engineers, industrial robot operation and maintenance (O & M) personnel, digital management professionals, and drone pilots.

Meanwhile, traditional production methods and processes are also undergoing profound changes as standardized and procedural production is gradually laced with customized and creative elements. Vocational education must be transformed through effective setup, talent cultivation models, curriculum development, resource development, and practical teaching systems to serve industrial development and promote student employment. Considering industrial demands, we should employ digital thinking when examining.

Industry–education integration, school-enterprise cooperation, and work-study alternation” and promote the alignment of education and talent chains with industry and innovation chains through digital transformation. Only by doing so can we achieve industrial digitization and intelligence, upgrade the industrial structure, and improve scientific and technological innovation capabilities.

### *We should enhance the applied research capabilities of the digital technology industry*

With the continuous development of science and technology, industrial technologies are evolving rapidly. The digital transformation of vocational education must adhere to the policy of deepening industry–education integration. Relying on the development of digital industrial technology, we should combine the latest scientific and technological knowledge with vocational skills to enrich the form and connotation of digital education.

### **Promoting “collaborative transformation” from focusing on a single perspective to benefiting the whole**

Digital technology can “break through the limitations of time and space, allowing for dissemination and sharing across schools, regions, and countries, providing equal opportunities and channels for people in different environments to access educational resources”.<sup>[30]</sup> In China, where education development is uneven, and there are significant gaps in educational resources between regions, urban and rural areas, and schools, digital transformation can effectively promote equal access to education internationally. Joint contributions and shared benefits in education are essential in building a community with a shared future for humankind, which aims to address global challenges through cooperation and sharing. Digital transformation will promote global cooperation, understanding, and sharing in education with its high situationality, accessibility, and nature of transcending temporal and spatial boundaries.

As a type of education that “provides accessibility for all and promotes employment”, vocational education has made significant contributions in narrowing the gap in education between urban and rural areas, training skilled workers, enhancing the adaptability of the labor market, promoting industrial upgrading and technological innovation, and fostering social equity and long-term national development. In the future, we should invest more digital resources in vocational education, integrate cutting-edge technologies such as AI, big data, and cloud computing into vocational education, and incorporate innovation and entrepreneurship elements, thus creating intelligent and digital vocational education models. We should promote the opening and sharing of educational

resources, overcome temporal and spatial constraints, and facilitate the comprehensive popularization of global exchanges in vocational education.

In addition, we should insist on mutual learning and creation. All forces should be united, and stakeholders, such as communities, industry associations, and enterprises, should be encouraged to participate in the digital transformation of vocational education. A collaborative educational model should be established with increased alignment between vocational education and social demands. Efforts should be made to promote the deep integration of vocational and general education, the connection between academic education and vocational training, and the combination of autonomous learning and lifelong learning, thus establishing a multi-level, diversified educational system.

Finally, we should promote the modernization, high-end development, and internationalization of China's vocational education with a broad vision. Through establishing international cooperation projects, organizing international vocational education exchanges, building world-class digital vocational education platforms, and providing high-quality educational resources in multiple languages and fields, we will popularize China's vocational education concepts and models, share China's experience in vocational education, contribute China's wisdom in vocational education, and lead the reform and innovative development of vocational education worldwide.

## CONCLUSION

Digital transformation in vocational education presents an irresistible trend and is in full swing in China, but there is still a long way to go. From a micro perspective, infrastructure and technological conditions form the first "digital divide". China has generally achieved leapfrog development and has even led the world in certain aspects. However, we have yet to overcome the second "digital divide," which is the digital literacy of "humans." We are now confronted with the significant task of unleashing the creativity of different subjects and promoting the multi-factor coupling and creation of digital technologies and resources through innovative thinking, while highlighting the characteristics of vocational education.

From a meso perspective, different educational institutions have different endowments and foundations. For institutions in underdeveloped regions, it is crucial to seize the opportunity for disruptive empowerment by digital transformation, innovate their development concepts and models, and explore development paths that suit their conditions, thus achieving leapfrog

development. From a macro perspective, in-depth discussions should be conducted regarding the necessity of developing an integrated development strategy for digital transformation at the national level. Furthermore, we must comprehensively promote the balanced development of equal access to education, coordinate the development of faculty, curriculum, and teaching material resources, and establish a community construction mechanism that features joint contributions, shared benefits, and common progress. While doing these, we must avoid the homogeneity caused by a "one-size-fits-all" approach, thus achieving the characteristic and high-quality development of vocational education.

## DECLARATION

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