

Research on the Innovative Development of International Education Management in Traditional Chinese Medicine Driven by Digital-Intelligent Technologies

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Abstract

Against the background of profound adjustments in the global public health governance landscape and the continued development of the “Health Silk Road”, international education in traditional Chinese medicine undertakes multiple core missions, including the dissemination of outstanding traditional Chinese culture, the international dissemination of traditional Chinese medicine knowledge systems, and the cultivation of internationally oriented interdisciplinary professionals. Clustered breakthroughs in digital-intelligent technologies such as big data, artificial intelligence, knowledge graphs, natural language processing, and virtual simulation have become the core driving force for transforming management models, system iteration, and the upgrading of educational modalities of international education in traditional Chinese medicine. Based on relevant theoretical frameworks of digital-intelligent empowerment, this paper systematically defines the core connotation of digital-intelligent empowerment and analyzes the practical dilemmas and technological application needs of international education management in light of the disciplinary characteristics of traditional Chinese medicine. From four dimensions, namely intelligent mining of traditional Chinese medicine knowledge and integration of international teaching resources, stratified and categorized personalized learning and full-process precision management, dynamic optimization of teaching resources and closed-loop control of educational quality, and the construction of cross-border smart platforms and ecological collaboration among multiple stakeholders, this paper provides an in-depth explanation of the internal mechanism by which digital-intelligent technologies drive management innovation. The study proposes a trinity development framework of data middle platform, smart teaching, and cross-border collaboration, with the aim of promoting the global optimal allocation of traditional Chinese medicine educational resources, renewing international student cultivation models, and upgrading the quality governance system for international education. This study enriches theoretical scholarship in the digitalization and internationalization of traditional Chinese medicine education and

provides theoretical reference and practical solutions for traditional Chinese medicine institutions in China to promote innovation in international education management and achieve high-quality development through digital-intelligent technologies.

Keywords: digital-intelligent technologies; international education in traditional Chinese medicine; management innovation; knowledge mining; development path

I. Introduction

1. Research Background and Policy Orientation

Traditional Chinese medicine is a cultural treasure shaped by five millennia of Chinese civilization and a core strategic resource for China's deep participation in global health governance and for jointly building a human community of health. With the in-depth advancement of the Belt and Road Initiative and the comprehensive implementation of the internationalization strategy for traditional Chinese medicine, international education in traditional Chinese medicine has entered a critical window of opportunity for large-scale and high-quality development. As of 2025, traditional Chinese medicine had been disseminated to 196 countries and regions worldwide, more than 30 countries and regions had established higher education programs or institutions in traditional Chinese medicine, and the number of international students coming to China to study traditional Chinese medicine had increased year by year.

In May 2023, General Secretary Xi Jinping clearly stated during a collective study session of the Political Bureau of the CPC Central Committee that China should optimize the layout of educational opening-up, coordinate the introduction of foreign educational resources with the global expansion of Chinese education, strengthen the "Study in China" brand, and enhance the international influence and global discursive power of Chinese education ^[5]. This instruction clarified the direction for the internationalized development of universities nationwide. The Ministry of Education's *Education Action for Promoting the Joint Construction of the Belt and Road* ^[5], the *Development Plan for Traditional Chinese Medicine under the Belt and Road Initiative (2016–2020)* ^[6], and the *14th Five-Year Plan for the Development of Traditional Chinese Medicine* ^[7] all identify international education in traditional Chinese medicine as a key area of support, thereby providing robust policy support for the development of the field.

At present, global industrial and supply chains are undergoing deep restructuring, and Chinese enterprises are accelerating their international expansion. In 2024, the number of overseas Chinese-funded enterprises exceeded 52,000, and the scale of foreign economic and trade cooperation expanded steadily. According to the *2024 White Paper on Overseas Talent in China's Manufacturing Industry* released by Tsinghua University, the shortage rate of internationally localized talent among Chinese enterprises going global reached 48%, while the insufficient supply of professionals in cross-cultural management, international compliance, and specialized technical fields has substantially increased the international operating costs of enterprises.

By contrast, the cohort of international students in China has grown in both scale and quality. In 2024, the total number of international students in China reached 572,000, which was 2.6 times that in 2013, when the Belt and Road Initiative was first proposed; 62% of these students came from countries along the Belt and Road, and approximately one third of the existing international students intended to seek employment in China or work for international Chinese-funded enterprises. International students in China possess linguistic advantages, cultural familiarity, and professional competence, making them natural bridges between Chinese enterprises and international markets. Accelerating the improvement of international education management in traditional Chinese medicine and cultivating, at scale, internationally oriented professionals with both competence in traditional Chinese medicine and cross-cultural practical capabilities are not only inherent requirements for serving national strategies but also urgent needs for advancing the comprehensive internationalization of traditional Chinese medicine.

2. Review of Domestic and International Research

In recent years, Chinese scholars have conducted extensive research in three major directions, namely digital-intelligent empowerment in the development of traditional Chinese medicine, the international dissemination of traditional Chinese medicine, and the digital transformation of education, thereby laying an important foundation for this study. In research on the digital-intelligent empowerment of traditional Chinese medicine, Chen Yingjie ^[1] constructed a theoretical framework and implementation path for the digital-intelligent empowerment of the international dissemination of traditional Chinese medicine culture and systematically explained the logic of application of big data and artificial intelligence in the cross-border dissemination of traditional Chinese medicine. Feng Chunlai's team has long worked in the fields of traditional Chinese medicine bioinformatics, network pharmacology, and intelligent computing, proposing multi-level action network analysis technology for Chinese materia medica ^[2] and a multi-target synergistic optimization method for multivesicular liposomes ^[3], and the complex systems thinking embedded in these studies can be transferred to the field of educational management innovation. Li Shao ^[16] proposed network pharmacology as a new paradigm for the modernization of traditional Chinese medicine, providing theoretical support for interdisciplinary methodological transfer.

In research on international education in traditional Chinese medicine, Zhang Boli et al. ^[9] systematically reviewed the current situation, problems, and countermeasures of international education and talent cultivation in traditional Chinese medicine and pointed out that the absence of standardization and insufficient faculty capacity are core constraints. Wang Qun et al. ^[11], from the perspective of cross-cultural adaptation among international students studying traditional Chinese medicine in China, proposed differentiated management strategies. Yang Jinsheng et al. ^[20] analyzed the current situation and challenges of international traditional Chinese medicine education and emphasized that the internationalization of educational standards is a key path to achieving breakthroughs.

In research on educational digital transformation, Huang Ronghuai et al. ^[15] systematically explained the connotation, characteristics, and implementation paths of

educational digital transformation, providing a theoretical reference for the analysis of digital-intelligent empowerment in this paper. Zhou Xuezhong et al.^[17] and Cui Meng et al.^[18] respectively examined fundamental issues such as the construction of traditional Chinese medicine knowledge graphs, terminology standardization, and multilingual translation, thereby providing technical pathways for the development of digital resources for international education.

A synthesis of the existing literature reveals two salient features of current research. First, research on the application of digital-intelligent technologies in traditional Chinese medicine modernization and cultural dissemination has become increasingly in-depth, whereas systematic research in the field of international education management remains relatively insufficient. Second, studies of international education in traditional Chinese medicine mostly focus on macro-level policies, cross-cultural adaptation, or single technical issues, and lack a systematic framework that integrates the full-chain application of digital-intelligent technologies from the perspective of management innovation. At the same time, institutions such as Beijing University of Chinese Medicine^[14], Tianjin University of Traditional Chinese Medicine^[13], and Henan University of Chinese Medicine^[27] have carried out partial explorations of digital-intelligent international education management and accumulated valuable practical cases, but a replicable and generalizable overall solution has not yet been formed. On the basis of the above research and practical explorations, this paper systematically investigates the theoretical logic, internal mechanism, and implementation path through which digital-intelligent technologies drive innovation in international education management in traditional Chinese medicine, in order to address the limitations of existing research and provide theoretical reference and practical solutions for the innovative development of sectoral management.

3. Current Development and Challenges of International Education in Traditional Chinese Medicine

In recent years, international education in traditional Chinese medicine has entered a stage of rapid development. As of 2023, acupuncture and moxibustion in traditional Chinese medicine had been applied in 196 countries and regions worldwide, and traditional Chinese medicine had officially entered the legal systems of 29 countries and regions. Statistics from the Ministry of Education and the National Administration of Traditional Chinese Medicine show that China's existing higher education institutions of traditional Chinese medicine enroll more than 20,000 international students each year from countries along the Belt and Road and from other regions worldwide, and the scale of education for international students in traditional Chinese medicine continues to expand. Meanwhile, overseas cooperative education programs in traditional Chinese medicine have progressed steadily, and many universities have established traditional Chinese medicine education bases in Southeast Asia, Africa, Europe, and other regions, forming a diversified pattern that combines study-in-China programs, overseas cooperative education, and online distance education.

The traditional management model of international education in traditional Chinese medicine faces three structural bottlenecks that constrain high-quality

development. First, traditional Chinese medicine theory is rooted in Chinese traditional culture, and core concepts such as yin-yang and the five elements, pattern differentiation and treatment, meridians, qi, and blood have strong cultural attributes; therefore, cross-border teaching must overcome the dual barriers of language translation and cultural understanding ^[9]. Second, international students come from a wide range of countries and differ markedly in medical background, knowledge structure, language proficiency, and learning motivation, making it difficult for traditional homogeneous teaching and broad-brush management models to fit their needs ^[11]. Third, cross-border education involves multiple languages, time zones, national laws, and educational systems, with long management chains and numerous collaborating stakeholders, making it far more complex than conventional domestic education management ^[10].

Beyond the above macro-level bottlenecks, international education in traditional Chinese medicine still faces deep-seated structural problems at the micro-operational level, which are concentrated in the following five aspects.

First, teaching standards are inconsistent and quality varies considerably. At present, no unified international quality standard or accreditation system for traditional Chinese medicine education has yet been established, and significant differences exist among countries and institutions in curriculum design, program duration, and practical training requirements. The absence of cross-linguistic translation standards for core concepts in traditional Chinese medicine and the uneven quality of textbook translation lead to systematic deviations in international students' understanding of core traditional Chinese medicine theories, making it difficult to effectively guarantee teaching quality.

Second, the teaching workforce remains insufficient, and there is a severe shortage of interdisciplinary internationalized talent. High-level international education in traditional Chinese medicine requires bilingual teachers with both profound professional knowledge of traditional Chinese medicine and cross-cultural teaching competence, but such interdisciplinary talents are extremely scarce. Existing teachers commonly suffer from inadequate foreign-language proficiency, insufficient cross-cultural communication skills, and outdated concepts of international education, making it difficult for them to respond effectively to the diverse learning needs of international students from different cultural backgrounds and seriously constraining the improvement of educational quality.

Third, the management system is outdated and the level of digitalization is relatively low. At present, a considerable proportion of traditional Chinese medicine institutions still rely on traditional administrative means for international education management and lack an integrated digital management platform covering enrollment, academic affairs, student services, and cross-border internships. Data silos across institutions and borders are prominent, and channels for information sharing remain fragmented. This not only results in low management efficiency, but also makes precise tracking of students' learning processes and personalized services difficult to achieve.

Fourth, cultural adaptation is difficult, and the cross-border learning support system is incomplete. When international students from different cultural

backgrounds receive traditional Chinese medicine education, they face not only language barriers but also deep conflicts between the philosophical system of Chinese traditional culture and their own cultural cognitive frameworks. Existing teaching models provide insufficient support for students' cross-cultural adaptation, and supporting service systems such as psychological counseling, cultural integration, and community building remain incomplete, leading to relatively low completion rates among some students and leaving overall educational outcomes to be improved.

Fifth, international recognition is insufficient, and mechanisms for mutual recognition of degrees and qualifications are lacking. Traditional Chinese medicine education has not yet gained official recognition in many countries, and graduates face qualification recognition barriers when practicing overseas, which seriously affects international students' employment prospects and learning motivation. Large differences in national policies and inconsistent accreditation standards restrict the international recognition and attractiveness of international education in traditional Chinese medicine and in turn affect the sustained recruitment of high-quality students.

The existence of these problems reveals systematic shortcomings in the management model, resource allocation, technical support, and international coordination of international education in traditional Chinese medicine. The rapid development of digital-intelligent technologies such as big data, artificial intelligence, knowledge graphs, and VR/AR virtual simulation provides a feasible pathway for systematically addressing developmental challenges and comprehensively promoting innovation in international education management in traditional Chinese medicine. The following sections of this paper systematically discuss the theoretical foundation, internal mechanism, and implementation paths of management innovation driven by digital-intelligent technologies.

II. Theoretical Foundations of Management Innovation Driven by Digital-Intelligent Technologies

1. Defining the Connotation of Digital-Intelligent Empowerment

Digital intelligence is a composite concept that deeply integrates digitalization and intelligent transformation. Unlike traditional, single-dimensional digitalization, it takes data as the core factor of production, intelligent algorithms as the driving force, and digital platforms as the supporting carrier, and it systematically reconstructs and reengineers traditional management processes, organizational models, and service systems, thus constituting the core technological foundation of educational management innovation ^[15]. The essence of digital-intelligent empowerment is not simply data collection, storage, and online migration; rather, it relies on technology to realize deep data mining, intelligent association of stakeholders, intelligent risk prediction, and automated decision generation, thereby achieving the innovative development goal of data-driven operations and intelligently optimized management.

In light of the development scenario of management innovation in international education in traditional Chinese medicine, this paper divides digital-intelligent empowerment in this field into three core connotations. First, with learners at the center, it integrates multidimensional data such as international students' entrance assessments, classroom learning, clinical practice, cross-cultural adaptation, and

academic evaluation to construct dynamic and three-dimensional learner digital profiles, thereby enabling an innovative transformation of management services from one-size-fits-all provision to precision-oriented services ^[24]. Second, with knowledge dissemination as the point of departure, it applies technologies such as AI machine translation, intelligent terminology alignment, virtual simulation, and multimodal content generation to break language and cultural barriers and promote innovation in the dissemination model of traditional Chinese medicine knowledge ^[18]. Third, with full-process management as the goal, it builds an integrated cross-border education management platform, connects full-chain data covering enrollment, student records, teaching, practical training, assessment, employment, and international cooperation, and forms a new closed-loop, traceable, and optimizable governance system for international education ^[12].

2. Disciplinary Specificity and Innovation Needs of International Education Management in Traditional Chinese Medicine

Traditional Chinese medicine combines humanistic, theoretical, and practice-oriented attributes, and the regional, institutional, and cultural differences involved in cross-border education further distinguish international education management in traditional Chinese medicine from ordinary higher education and general management of international students in other disciplines. The limitations of traditional management models have become increasingly evident and have forced comprehensive innovation in management concepts, methods, and systems ^[19]. Based on existing research and practice, its specificity and innovation needs are mainly reflected in three aspects.

First, the knowledge system is complex and culturally embedded. The theoretical system of traditional Chinese medicine has developed over thousands of years and integrates content from philosophy, medicine, agriculture, and other fields. Core concepts such as yin-yang, the five elements, visceral manifestation theory, meridians, and formula compatibility have strong culture-specific characteristics and are difficult to interpret directly through the framework of modern Western medicine. At the same time, skills such as acupuncture, tuina therapy, Chinese materia medica processing, and clinical pattern differentiation are highly practical. International teaching must both preserve the authenticity of traditional Chinese medicine knowledge and adapt to the cognitive habits of international learners, while traditional offline teaching management models show obvious limitations and urgently require digital-intelligent technologies to innovate the forms of knowledge transmission and teaching management ^[20].

Second, learners are highly heterogeneous. International students who come to China to study traditional Chinese medicine come from different countries and regions around the world; some have systematic backgrounds in Western medical education, while others are beginners with no prior background. Students also differ considerably in Chinese, English, and native-language proficiency, and different regional cultures vary significantly in their acceptance of traditional Chinese medicine concepts ^[25]. Uniform curricula, teaching pace, and management standards cannot match the needs of stratified cultivation, making personalized management and differentiated services an inevitable direction of management innovation.

Third, educational scenarios require cross-border collaboration. International education in traditional Chinese medicine covers diverse scenarios, including domestic offline teaching, international joint training, cross-border distance learning, overseas clinical internships, and Chinese-foreign academic exchanges, and it involves multiple stakeholders such as domestic universities, international partner institutions, international industry organizations, traditional Chinese medicine enterprises, and education regulators in different countries. Collaborative management across time zones, countries, and systems lengthens the management chain and increases the difficulty of communication, coordination, and supervision. Traditional offline and decentralized management models are inefficient, and digital-intelligent technologies must be used to innovate cross-border collaborative management mechanisms ^[11].

3. Interdisciplinary Methodological Transfer: From Chinese Materia Medica Network Research to Intelligent Innovation in Educational Management

Complex systems analysis methods developed in fields such as network pharmacology and bioinformatics provide important interdisciplinary methodological inspiration for innovation in international education management in traditional Chinese medicine ^[16]. Using complex network topology as an analytical framework to identify core nodes, functional modules, and key pathways in multi-factor and multi-actor systems is highly consistent with the systemic characteristics of international education management problems in traditional Chinese medicine and provides a theoretical tool for constructing a data-driven and networked analytical paradigm for management innovation ^[2].

International education in traditional Chinese medicine is itself a complex large-scale system composed of stakeholders such as students, teachers, administrators, international partner institutions, and industry enterprises, as well as layers such as language learning, theoretical teaching, skills training, cultural adaptation, and career development. By drawing on the paradigm of Chinese materia medica network analysis, one can construct a network of associations among international education elements, quantitatively analyze the internal relationships among variables such as language proficiency, foundational knowledge of traditional Chinese medicine, cultural adaptability, practical ability, and employability, and identify key nodes affecting learning outcomes and training quality. This provides data support for innovative optimization in management links such as enrollment selection, curriculum design, academic intervention, and career guidance ^[17].

The idea of multi-target synergistic optimization ^[3] can be directly transferred to multi-objective collaborative training scenarios in international education in traditional Chinese medicine, providing methodological reference for systematic management innovation that simultaneously improves multiple training goals such as language proficiency, foundational knowledge of traditional Chinese medicine, cross-cultural adaptation, and clinical skills. Meanwhile, the deep industry-university-research cooperation model ^[4] provides a practical template for traditional Chinese medicine institutions to connect with industry enterprises, promote digital-intelligent educational management innovation, and realize the integrated development of industry and education. The cooperation pathway between enterprises and

international universities explored by the collateral disease theory research team of Yiling Pharmaceutical, which introduced bilingual courses in collateral disease theory into international institutions in Singapore, Thailand, and other countries, further verifies the practical feasibility of transferring interdisciplinary methodologies to innovation in international education management in traditional Chinese medicine.

III. Internal Mechanisms by Which Digital-Intelligent Technologies Drive Management Innovation in International Education in Traditional Chinese Medicine

1. Intelligent Knowledge Mining and Cross-Cultural Transformation of Teaching Resources

The digital and international transformation of knowledge resources is the primary entry point for innovation in international education management in traditional Chinese medicine. Traditional Chinese medicine classics contain complex specialized terminology and an extensive theoretical system, and traditional manual approaches to organization, translation, and compilation are inefficient and error-prone, making them unable to support the development of large-scale international teaching ^[21]. Relying on technologies such as machine learning, natural language processing, and knowledge graphs, digital-intelligent technologies realize intelligent mining, multilingual conversion, and systematic integration of teaching resources for traditional Chinese medicine knowledge, thereby completing an innovative upgrade of the resource management model.

At the level of intelligent text and terminology processing, deep-learning translation models and automatic professional terminology alignment algorithms can enable accurate multilingual translation of traditional Chinese medicine classics, textbooks, and courseware, and can establish multilingual comparative lexicons of core traditional Chinese medicine terms, thus addressing industry pain points such as inconsistent professional translation and semantic deviation ^[18]. Using knowledge graph technology, the five major knowledge systems of traditional Chinese medicine foundational theory, Chinese materia medica, formulas, acupuncture and moxibustion, and clinical cases can be organized to build an international teaching knowledge graph for traditional Chinese medicine with clear hierarchy and semantic interoperability, enabling intelligent association, accurate retrieval, and visual presentation of knowledge points and transforming traditional forms of knowledge management ^[17].

At the level of knowledge system reconstruction and teaching transformation, the introduction of multi-level network analysis technology for Chinese materia medica ^[2] transfers the network logic of component, target, and efficacy in Chinese materia medica to teaching resource development. It constructs a teaching knowledge network of traditional Chinese medicine concepts, theoretical connotations, clinical manifestations, and practical applications, transforming abstract compatibility rules and pattern differentiation thinking into intuitive visual content and lowering the cognitive threshold for international students. The multimodal knowledge graph-based intelligent question-answering system developed by the team of Liu Xinxin and Tang Chaohui at Chengdu University of Traditional Chinese Medicine ^[28] transforms

abstract traditional Chinese medicine theory into visual and interactive content and provides international students with an efficient self-directed learning tool, offering a replicable model for the development of digital-intelligent teaching resources.

2. Learner Digital Profiles and Innovation in Personalized Training Management

In response to the pronounced heterogeneity of international students, digital-intelligent technologies use data profiling, adaptive systems, and intelligent early warning as core mechanisms to build a new full-process framework of personalized training and precision management, promoting the innovative transformation of the management model from unified control to individualized cultivation^[9].

First, multidimensional digital profiles should be constructed. Data such as entrance competency assessments, language proficiency levels, online learning trajectories, classroom interaction data, clinical practice records, and cross-cultural adaptation assessments should be integrated to establish dynamic digital profiles for each international student, accurately distinguish knowledge weaknesses, ability characteristics, and learning needs, and provide a basis for stratified and categorized innovative management models^[24]. Second, innovation in full-process personalized learning support should be promoted. In the enrollment stage, machine-learning prediction models can comprehensively evaluate applicants' academic backgrounds, language abilities, and cultural adaptability, thereby optimizing student selection criteria. In daily teaching, AI adaptive learning systems can dynamically adjust course difficulty, teaching content, and learning paths according to students' mastery of specific knowledge points. In practical teaching, VR/AR virtual diagnosis and treatment systems and AI standardized patients can overcome the limitations of physical practical-training venues, provide international students with immersive practical training, and automatically complete performance scoring and corrective guidance^[22]. Finally, innovation in academic and psychological intelligent early-warning intervention should be implemented. Relying on big data analysis models, institutions can monitor students' academic performance, online activity, and cross-cultural adaptation indices in real time, establish risk warning mechanisms, promptly identify issues such as academic difficulties and cultural conflicts, trigger human intervention, and form a new management architecture of data monitoring, algorithmic warning, and human-assisted support^[11].

The team of Ma Yulu at Nanjing University of Chinese Medicine, relying on an AI practice intelligent agent, collected full-process data from experimental teaching in Chinese materia medica, constructed student ability profiles, and delivered differentiated experimental tasks to international students with different foundations, thereby achieving personalized innovation in experimental teaching management. This achievement was selected as a high-quality application case in national medical education and provides a practical reference for traditional Chinese medicine institutions to promote personalized management^[29].

3. Innovation in Teaching Resource Allocation and Closed-Loop Quality Control

The scarcity of high-level bilingual teachers, the shortage of cross-border practical training sites, and the difficulty of coordinating teaching across time zones are resource bottlenecks that have long constrained the improvement of international education quality in traditional Chinese medicine and are also key areas for

management innovation^[10]. Digital-intelligent technologies realize innovation in the optimized allocation of teaching resources and closed-loop management of educational quality from three dimensions: faculty deployment, practical-training resources, and quality control.

In terms of teacher and practical training resource allocation, AI real-time translation and intelligent terminology annotation tools reduce barriers to bilingual teaching and expand the pool of available teachers. Remote collaborative teaching platforms integrate high-quality traditional Chinese medicine teachers nationwide and enable faculty sharing across regions and time zones. VR virtual clinics, digital Chinese materia medica specimen libraries, and online processing training systems compensate for the shortage of international clinical bases and laboratory sites and substantially reduce the infrastructure costs of practical training^[21]. The international education team of Hebei University of Chinese Medicine, relying on the digital platform of the Confucius Institute for traditional Chinese medicine, integrated high-quality domestic teachers to conduct remote teaching for Brazil and Latin America and combined this with VR traditional Chinese medicine training systems for practical teaching, effectively solving the problems of scarce bilingual teachers and insufficient training resources in Latin America.

In terms of closed-loop control of teaching quality, big data analysis can track learning outcomes across different courses and teaching modules, identify blind spots in knowledge understanding and defects in instructional design, and in turn promote dynamic optimization of course content and teaching methods. At the same time, multidimensional indicators such as student evaluations, peer review, online teaching data, and practical training outcomes can be integrated to construct a comprehensive teacher evaluation system suited to international education scenarios and improve teacher assessment and management mechanisms^[12]. The team of Xu Jiangyan and Rao Hong at Henan University of Chinese Medicine built a big data monitoring platform for teaching quality for a China-Malaysia joint China–Malaysia traditional Chinese medicine education program, collected teaching data from teachers and students in both countries in real time, dynamically optimized the curriculum system and assessment standards, thereby ensuring the steady improvement of cross-border joint education quality.

4. Construction of Cross-Border Smart Platforms and Innovation in Multi-Stakeholder Collaborative Ecosystems

International education in traditional Chinese medicine involves multiple stakeholders, including universities, enterprises, international organizations, and government departments, and a single digital tool cannot meet collaborative needs. Therefore, an integrated cross-border smart platform must be established to innovate a multi-party educational ecosystem and collaborative management model^[11].

From the perspective of platform architecture, a digital-intelligent platform for international education in traditional Chinese medicine consists of four layers. The first is the infrastructure layer, which builds a cloud computing architecture that supports multilingual services, cross-time-zone coordination, and cross-border data compliance. The second is the data resource layer, which integrates core data assets such as knowledge graphs, student digital files, teaching resource repositories, and

global databases of traditional Chinese medicine institutions. The third is the application service layer, which deploys functional modules such as intelligent enrollment, adaptive learning, remote practical training, cross-cultural services, and employment matching. The fourth is the collaborative decision-support layer, which builds management dashboards, data reports, and trend prediction systems to support strategic decision-making by administrators. The international education research team of Nanjing University of Chinese Medicine, relying on the platform of the WHO Collaborating Centre for Traditional Medicine, built a global collaborative database for traditional Chinese medicine education that integrates educational information and talent data from more than 90 countries and regions, making it an important carrier for cross-border collaborative decision-making.

From the perspective of ecological collaboration mechanisms, four new collaborative systems can be established through digital-intelligent platforms. First, inter-university collaboration enables traditional Chinese medicine institutions in China to share teaching resources, teaching staff, and credit systems and to form an international education alliance for traditional Chinese medicine. Second, cross-border collaboration links international Confucius Institutes, overseas traditional Chinese medicine centers, and partner universities to achieve full-chain connectivity of domestic teaching, international practical training, and remote guidance. Third, industry-education collaboration draws on the industry-university-research cooperation model ^[4] and joins with international traditional Chinese medicine enterprises to jointly build talent training platforms aligned with industry job demands. Fourth, collaboration on international standards relies on platforms to submit data to international organizations such as WHO and the ISO/TC249 Technical Committee on Traditional Chinese Medicine, participate in standard setting, and enhance China's discursive influence in global governance of traditional Chinese medicine education ^[19]. The “two-country, four-party” industry-education integration community developed by the joint research and development team of Taishan Nursing Vocational College created bilingual digital textbooks and VR training courses for Tajikistan, realizing deep collaboration among institutions, enterprises, and international organizations and providing a new paradigm for the overseas expansion of traditional Chinese medicine vocational education.

IV. Implementation Pathways for Management Innovation in International Education in Traditional Chinese Medicine Driven by Digital-Intelligent Technologies

1. Building a Standardized Data Governance System to Consolidate the Digital Foundation for Management Innovation

Data constitute the core foundation for digital-intelligent transformation and management innovation. Traditional Chinese medicine institutions need to incorporate international education data governance into the overall plan for institutional internationalization, establish a data system with unified standards, security and compliance, and controllable quality, and lay a solid foundation for management innovation.

First, multilingual data standardization should be advanced. Institutions should compile data dictionaries for international education in traditional Chinese medicine and multilingual alignment specifications for professional terminology, break down data barriers among systems such as enrollment, academic affairs, student management, international practice, and employment services, and build a unified international education data middle platform. They may draw on the data governance experience of Shen Yicai's team at Henan University of Chinese Medicine ^[27], including the concepts of “one table per teacher” and “one table per student”, to unify multilingual data formats and statistical standards and achieve cross-system data interoperability and sharing.

Second, cross-border data compliance mechanisms should be established. By benchmarking against domestic and international data regulations such as the GDPR and China's Personal Information Protection Law (PIPL), institutions should implement classified and graded data management, standardize cross-border data transfer processes, and balance data sharing with privacy protection ^[23]. Referring to the data compliance management framework of the “Xinhua Chinese Materia Medica” large model at Beijing University of Chinese Medicine ^[26], institutions should improve rules for the cross-border transfer of international students' personal information and teaching data and ensure data security.

Third, data quality governance should be conducted on a regular basis. Institutions should establish data quality evaluation indicators and regularly complete data cleaning, verification, and error correction to ensure the accuracy of data analysis and intelligent decision-making and support the implementation of various management innovation measures.

2. Creating an Integrated Smart Teaching Management Platform as the Core Carrier of Management Innovation

Following the principles of openness, intelligence, and integration, institutions should upgrade existing digital systems and create a smart platform covering all operations, all populations, and all scenarios, thereby promoting comprehensive innovation in management processes and service models through technological carriers. First, an international intelligent teaching system should be built by integrating functions such as multilingual translation, adaptive learning, virtual simulation training, and cross-time-zone livestreaming to provide round-the-clock teaching services for learners worldwide. Mature tools such as the AcuAssistant intelligent acupuncture system of Shanghai University of Traditional Chinese Medicine and the knowledge graph question-answering system of Chengdu University of Traditional Chinese Medicine ^[28] can be integrated to enrich the practical training and teaching modules of the platform. Second, full-life-cycle digital files for international students should be established, covering the entire process of admission, learning, practical training, cultural adaptation, graduation, and employment, so as to realize one digital file per student and dynamic updating. Third, intelligent decision-making management dashboards should be deployed to display enrollment data, teaching quality, student dynamics, and the progress of international cooperation in real time, thereby providing data support for administration at both university and school levels. Drawing on the model evaluation ideas of Tang Wenchao's team at Shanghai

University of Traditional Chinese Medicine^[26], intelligent teaching quality evaluation modules can be added to the dashboard to enable dynamic control.

3. Cultivating Interdisciplinary Digital-Intelligent Talent Teams to Activate the Endogenous Driving Force of Management Innovation

Talent is the key to technological implementation and management innovation. It is necessary to simultaneously improve the capabilities of existing personnel and introduce cross-disciplinary talent, build professional digital-intelligent management teams, and provide human resource support for continuous innovation. First, specialized training in digital literacy should be carried out. Courses on data analysis, AI teaching tools, cybersecurity, and cross-border digital services should be offered to international education administrators and bilingual teachers to enhance the technological application and innovation capabilities of frontline personnel. Second, interdisciplinary and cross-sector talent should be introduced. Institutions should recruit talents with backgrounds in traditional Chinese medicine, data science, educational technology, and international management, and establish dedicated research, development, and management teams to address talent shortages. Third, industry-university-research collaborative innovation should be deepened. Institutions should collaborate with AI technology enterprises, international traditional Chinese medicine enterprises, and educational research organizations to jointly develop specialized tools and systems adapted to international education scenarios in traditional Chinese medicine and promote the transformation of technological achievements and the continuous iteration of management models^[4].

4. Deepening Cross-Border Collaboration and International Cooperation to Expand the Development Boundary of Management Innovation

Based on the internationalization strategy of traditional Chinese medicine, institutions should rely on digital-intelligent platforms to deepen multi-level international cooperation, continuously expand the application scenarios and development space of management innovation, and build an international brand of “digital traditional Chinese medicine”. First, a “Belt and Road” remote education resource-sharing network for traditional Chinese medicine should be established by integrating the international training program platform of Zhao Jing’s team at the China Academy of Chinese Medical Sciences^[30] and the resources of the Confucius Institute of Hebei University of Chinese Medicine to build a cross-border teaching alliance. Second, institutions should deeply participate in the development of international traditional Chinese medicine standards and rely on the global traditional Chinese medicine education database of Nanjing University of Chinese Medicine to aggregate educational data from various countries and provide data support for the formulation of international education standards and industry norms^[19]. Third, two-way coordination between “going global” and “bringing in” should be promoted by exporting high-quality digital teaching resources while optimizing the experience of studying in China and attracting high-quality international students. Fourth, cross-cultural teaching forms should be innovated by using knowledge graph visualization and AIGC multimodal content generation technologies to transform abstract traditional Chinese medicine theories and mitigate cross-cultural barriers to understanding^[24].

V. Conclusions and Prospects

Against the triple background of high-quality development of the Belt and Road Initiative, construction of the “Health Silk Road”, and digital transformation of education ^[8], international education in traditional Chinese medicine has become an important carrier for disseminating outstanding traditional Chinese culture, cultivating internationally oriented professionals, and expanding global health cooperation. Traditional management models can no longer meet the development requirements of the new era, and management innovation has become an inevitable choice for improving the quality, efficiency, stability, and long-term sustainability of international education in traditional Chinese medicine. With capabilities in data mining, intelligent analysis, virtual simulation, and cross-border collaboration, digital-intelligent technologies directly address the three core challenges of knowledge complexity, student heterogeneity, and cross-border management complexity in international education in traditional Chinese medicine, and comprehensively drive management innovation across resource management, student services, quality control, and ecological collaboration.

This paper systematically reviews the theoretical connotation and disciplinary applicability of digital-intelligent empowerment and, in combination with Feng Chunlai's team's interdisciplinary research achievements in Chinese materia medica network analysis ^[2], multi-target optimization ^[3], and industry-university-research cooperation ^[4], integrates the frontier achievements and practical cases of dozens of digital-intelligent and internationally oriented research teams in traditional Chinese medicine, including those from Beijing University of Chinese Medicine, Shanghai University of Traditional Chinese Medicine, Henan University of Chinese Medicine, and the China Academy of Chinese Medical Sciences. It clarifies the internal mechanism by which digital-intelligent technologies drive innovation in international education management in traditional Chinese medicine, constructs a complete implementation path across four dimensions: data governance, platform construction, talent cultivation, and international cooperation, and proposes a trinity development framework of data middle platform, smart teaching, and cross-border collaboration. The practices of research teams and international education teams at many traditional Chinese medicine institutions in China demonstrate that promoting management innovation through digital-intelligent technologies can effectively improve the management efficiency, teaching quality, and international influence of international education in traditional Chinese medicine.

In light of current technological development and industry trends, future research can be deepened in four directions. First, it may explore the application scenarios and ethical norms of generative artificial intelligence (AIGC) in the development of international traditional Chinese medicine textbooks, the development of multilingual courseware, and the creation of cross-cultural teaching content ^[24]. Second, it may study the legal framework, compliance system, and risk prevention and control mechanisms for cross-border data flows in traditional Chinese medicine to ensure the compliant operation of digital management innovation. Third, it may explore new educational and management models that deeply integrate artificial intelligence with international education in traditional Chinese medicine and create a new paradigm for

innovative development. Fourth, it may analyze the pathways by which digital-intelligent technologies support balanced development in international education in traditional Chinese medicine, narrow regional disparities in educational provision, and fully realize the inclusive value of management innovation. The digital-intelligent innovation of international education management in traditional Chinese medicine is a long-term systematic project that requires coordinated efforts from academia, institutions, industry enterprises, and international organizations to continuously promote technological innovation, theoretical improvement, and practical implementation, thereby supporting the comprehensive global development of traditional Chinese medicine.

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