

Exploration and Practice of Interdisciplinary Talent Cultivation of Medicine-Engineering-Information Technology in the Era of Intelligent Healthcare

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Abstract: In the era of smart healthcare, this paper details Zhejiang Chinese Medical University's concrete reform initiatives addressing challenges in cross-disciplinary talent cultivation through Medicine-Engineering-Information integration. The institution has implemented comprehensive measures spanning high-caliber interdisciplinary faculty development. These include deeply integrated curricula, a "Practice, Competition, Research and Application" pedagogical framework, digital healthcare and AI-enabled medical case repositories, university, hospital, and enterprise collaborative platforms, and Engineering-education integration mechanisms. These reforms demonstrate measurable success, providing a viable pathway for training innovative interdisciplinary professionals in New Medical Education.

Keywords: Medicine-engineering-information integration; New medical education; Talent cultivation

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1. Introduction

With the accelerated convergence of a new round of scientific and technological revolution and industrial revolution represented by artificial intelligence and big data, the in-depth interdisciplinary integration between medicine and multiple disciplines has gained fresh impetus, bringing unprecedented challenges and opportunities to medical education ^[1]. "The Guiding Opinions on Accelerating the Innovative Development of Medical Education" issued by the State Council in 2020 clearly proposes to drive medical education innovation with the New Medicine Initiative and vigorously promote the in-depth interdisciplinary integration of medicine and engineering ^[2]. Advancing the development of the New Medicine Initiative featuring interdisciplinary integration and integrated innovation has become an important measure to implement the strategy of building a powerful country in education and advancing the Healthy China Initiative. Meanwhile, cultivating innovative talents through the interdisciplinary integration of medicine, engineering

and information technology serves as a breakthrough for realizing independent innovation and transforming research paradigms, as well as an incubator for training interdisciplinary innovative medical talents ^[3].

Against this backdrop, exploring and discussing the training model for innovative talents under the New Medicine Initiative via interdisciplinary integration of medicine, engineering and information technology is of great significance for cultivating high-caliber talents capable of meeting future healthcare demands.

2. Demands and current status of cultivating innovative talents for the New Medicine Initiative via interdisciplinary integration of medicine, engineering and information technology

2.1. Talent demands driven by the development of the new medicine initiative

In the era of intelligent healthcare, with the rapid advancement of artificial intelligence, big data, the Internet of Things and other technologies, the medical sector is undergoing a paradigm shift from experience-based medicine to precision medicine and smart healthcare. The extensive application of surgical robots, wearable health monitoring devices, AI-assisted medical image diagnosis and other technologies is promoting the transformation of medical models towards intelligence, telemedicine and personalization ^[4]. Consequently, there is a growing demand for interdisciplinary innovative talents under the New Medicine Initiative who can integrate medical knowledge, information technology and engineering capabilities to tackle complex medical problems.

2.2. Current status of talent cultivation

At present, medical education abroad demonstrates extensive integration with engineering and relevant technologies. The interdisciplinary integration of medicine, engineering and information technology permeates interdisciplinary curriculum design, cross-disciplinary research and collaborative projects, construction of interdisciplinary platforms, development of digital health systems, AI-assisted applications, technical skill assessment and other fields ^[5]. In contrast, domestic talent cultivation under the New Medicine Initiative mainly adopts measures including establishing interdisciplinary training pathways, adding integrated interdisciplinary courses, forming interdisciplinary teaching teams, widely deploying integrated educational resources of medicine, engineering and information technology, improving teachers' research capabilities, developing curriculum clusters integrating medicine and information technology, reconstructing classrooms empowered by information technology and integrating resources. These measures aim to cultivate interdisciplinary talents with innovative thinking and practical capabilities to meet the challenges and demands of the future healthcare industry.

Zhejiang University has established a disciplinary integration system featuring solid foundations in medicine-liberal arts and medicine-science, engineering-driven medical innovation, medicine-agriculture collaboration, and intelligent medicine-information integration. It adopts the dual pathways of “X + Medicine” and “Medicine + X” to cultivate outstanding interdisciplinary talents ^[6]. Peking Union Medical College puts forward three key concepts: multidisciplinary integration, “Broad Medicine” talents, and exploration of the New Medicine Initiative, so as to cultivate top-tier interdisciplinary innovative medical talents with multidisciplinary backgrounds ^[7]. Shanghai Jiao Tong University has built a two-wheel-driven cultivation system guided by clinical demands and supported by engineering technologies ^[8]. Xi'an Jiaotong University has established a cultivation system for interdisciplinary medical postgraduates led by scientific and

technological innovation, proposed the cultivation philosophy of “clinical guidance, technological support, diversified interdisciplinarity and system reconstruction”, and set the training objectives for interdisciplinary innovative medical talents: “understanding clinical demands, possessing engineering thinking, mastering cutting-edge knowledge and having strong innovation potential” ^[9,10]. Zhejiang Chinese Medical University has developed a talent cultivation model for informatization of traditional Chinese medicine characterized by “integrated Chinese and Western medicine, interdisciplinary integration of medicine, engineering and information technology, and university-hospital-enterprise coupling”. The talent cultivation model is implemented through a teaching system driven by information and oriented to knowledge coherence, resource sharing and innovation practice platforms for medicine, engineering and information technology, as well as a practical education mode of “training, competition, research and practice”.

2.3. Deficiencies in existing talent cultivation models

First of all, the existing curriculum system lacks in-depth integration. It merely adds partial medical or engineering content onto original courses with clear disciplinary boundaries. Medical courses and engineering-information courses are simply combined without effective communication and deep integration between disciplines, and students are provided with insufficient teaching scenarios to stimulate innovative application. The curriculum system is undergoing a paradigm transformation from knowledge transmission to intelligent construction ^[11].

Secondly, there is insufficient top-level design for practical platforms cultivating innovative talents under the New Medicine Initiative through interdisciplinary integration of medicine, engineering and information technology ^[12]. Communication and cooperation between practical platforms, medical institutions and enterprises remain inadequate. Students are deprived of sufficient engineering practice opportunities, and the penetration of knowledge across different disciplines is limited, making it difficult for students to develop integrated medicine-engineering thinking and solid technical capabilities ^[3]. Amid the rapid industrial development, universities fail to fully investigate market and clinical practical demands when designing practical teaching sessions or cannot incorporate such demands into teaching content in a timely and effective manner.

Thirdly, the mechanism of university-hospital-enterprise cooperation platforms needs optimization. Enterprises and hospitals lack enthusiasm for participating in university practical teaching. Sustainable and win-win cooperation mechanisms are absent, leading to loose partnerships and isolated operation among participants ^[13].

Finally, a unified teaching evaluation system for cultivating New Medicine talents via interdisciplinary integration of medicine, engineering and information technology has not yet been established nationwide. Discrepancies exist among universities in terms of training models, teaching content, teaching methods, curriculum systems and quality control procedures. Consensus has not been reached on the systematic framework of talent cultivation and professional certification standards for integrated medicine-engineering education ^[1], which remains at the stage of academic research and discussion ^[14,15].

These deficiencies indicate that domestic education under the New Medicine Initiative featuring interdisciplinary integration of medicine, engineering and information technology needs further improvement and enhancement so as to elevate education quality and optimize talent cultivation.

3. Reform and practice of talent cultivation

As Zhejiang Province accelerates its march into the era of intelligent healthcare, Zhejiang Chinese Medical University adheres to the school-running philosophy of “serving the modernization of traditional Chinese medicine and boosting the development of digital Chinese Medicine”. Based on the strategic demands of Healthy China and Digital China, the University focuses on three cutting-edge directions: smart healthcare, health industry and intelligent medical equipment. It promotes collaborative innovation among industry, university, research institutes, and end users, facilitates in-depth integration of medicine, engineering, and information technology, constructs an interdisciplinary disciplinary system, and forms a distinctive talent cultivation framework for innovative talents under the New Medicine Initiative.

3.1. Building a high-level teaching team with interdisciplinary background

The University optimizes faculty structure and introduces high-level talents, prioritizing recruitment of doctors and postdoctoral researchers with interdisciplinary research backgrounds in medicine, engineering and information technology to strengthen the disciplinary interdisciplinary advantages of the teaching team. It supports faculty development by encouraging domestic and overseas academic visits and international exchanges to broaden academic horizons and enhance interdisciplinary teaching and research capabilities. The University deepens university-hospital-enterprise collaboration by engaging university scholars, enterprise technical experts and clinical backbone physicians as industrial mentors, establishing a dual-tutor system consisting of academic tutors and industrial mentors to realize thorough integration of theoretical teaching and industrial practice. It also improves the mechanism for innovation team building. Relying on affiliated hospitals, internal and external research institutes and industry-university-research bases, the University encourages faculty to carry out collaborative research with industries and hospitals, advancing the transformation of scientific research achievements and teaching innovation.

3.2. Constructing a deeply integrated curriculum system of medicine, engineering and information technology to break disciplinary barriers

Centered on the industrial demands of smart health and digital healthcare and guided by practical clinical problems, three core directions are refined: medical data analysis, medical digital image processing and intelligent medical instruments. High-quality teaching resources at home and abroad are integrated to reconstruct a distinctive curriculum system featuring tripartite in-depth integration of medicine, engineering and information technology. The organic integration of medicine, engineering and information technology is realized through curriculum cluster development. Supported by comprehensive curriculum modules and interdisciplinary practical projects, students are cultivated to develop systematic thinking and equipped with three capabilities: (1) basic medical capabilities to understand clinical demands and medical problems; (2) capability of applying information technology to interpret medical and engineering problems using big data, artificial intelligence, Internet of Things and other technologies; (3) interdisciplinary innovation capability to integrate multi-disciplinary knowledge to address challenges in complex medical scenarios. Reconstructed based on interdisciplinary integration and practice-oriented design, the curriculum system broadens students' knowledge horizons, stimulates innovative thinking, facilitates knowledge integration and application, and provides systematic support for cultivating interdisciplinary talents integrating medicine, engineering and information technology.

3.3. Exploring implementation paths of interdisciplinary integration and establishing a practical teaching system of “training, competition, research and practice”

Based on over a decade of practical exploration, an innovative practical teaching system centering on interdisciplinary integration of medicine, engineering and information technology has been constructed.

- (1) Training: Relying on the interdisciplinary comprehensive practice platform, systematic training is conducted to foster students’ awareness of innovation, and modular experimental case teaching consolidates students’ fundamental practical abilities.
- (2) Competition: Various disciplinary competitions are adopted to expand and strengthen students’ innovative capabilities.
- (3) Research: Cooperating with laboratories of medicine, engineering and information technology and implementing the undergraduate mentor system, students are organized to participate in cutting-edge research projects to explore new technologies and methods and develop innovative practical capabilities.
- (4) Practice: In collaboration with the Institute of Medicine, Engineering and Information Technology, Research Center for Medical and Healthcare Big Data and Institute of Digital Chinese Medicine, the University gives full play to the dual-tutor system of academic and industrial mentors based on practical clinical demands to improve students’ research literacy and engineering practice capabilities.

3.4. Developing digital and intelligent medical cases to enrich platform resources

Representative and forward-looking experimental themes integrating medicine, engineering and information technology are selected. According to the demands of medical scenarios, teachers design technical implementation schemes for interdisciplinary integration, decompose complex technical systems into independently operable experimental modules, and introduce desensitized real medical data for student experiments. This enables students to access real medical data features and diagnostic challenges, improving the authenticity and challenge of experimental cases and developing practical and innovative experimental teaching resources.

3.5. Establishing an industry-education integration mechanism featuring inter-university collaboration, university-hospital integration and university-enterprise symbiosis to lay a foundation for cooperation

The University collaborates with well-known universities at home and abroad to build the Institute of Digital Chinese Medicine and the International Laboratory for Digital Diagnosis and Treatment of Integrated Chinese and Western Medicine, realizing credit mutual recognition and faculty sharing. A medical information innovation base is set up in affiliated hospitals, where students participate in the intelligent and digital construction of integrated Chinese and Western medicine diagnosis and treatment information systems. The University cooperates with medical AI enterprises to build talent bases for medicine, engineering and information technology, develop smart Chinese Medicine cloud platforms and intelligent Chinese Medicine health products, establish industrial colleges, and jointly cultivate interdisciplinary innovative talents under the New Medicine Initiative who possess knowledge of medicine, master data technologies and are proficient in artificial intelligence.

4. Outcomes of talent cultivation reform

Through comprehensive practice of integrated Chinese and Western medicine, interdisciplinary integration of

medicine, engineering and information technology, and university-hospital-enterprise coupling, the University has achieved fruitful results in major development, construction of interdisciplinary platforms for medicine, engineering and information technology, and cultivation of innovative talents under the New Medicine Initiative.

Among the University's 14 medical majors, 6 have offered modular information-related courses under the New Medicine Initiative, 5 have launched integrated courses of medicine, engineering and information technology, and all 3 information-related engineering majors have set up a series of new integrated courses combining medicine, engineering and information technology.

The University's interdisciplinary platforms cover multi-level construction. There are five provincial engineering research centers: Engineering Research Center for Smart Healthcare of Chinese Medicine "Preventive Treatment of Disease", Engineering Research Center for Key Technologies and Equipment of Chinese Medicine Artificial Intelligence, Engineering Research Center for Characteristic Technology and Intelligent Equipment of Chinese Medicine Orthopedics, Engineering Research Center for Intelligent Equipment of Integrated Chinese and Western Medicine for Chronic Diseases, and Engineering Research Center for Intelligent Rehabilitation Technology and Equipment of Chinese Medicine. Multiple international scientific and technological cooperation platforms, including the Zhejiang-Japan Joint Laboratory for Digital Diagnosis, Treatment and Equipment of Major Brain Diseases with Integrated Chinese and Western Medicine, have been established. In addition, university-level research institutions such as the Institute of Digital Chinese Medicine and Zhejiang Chinese Medical University International Artificial Intelligence Research Center have been built.

Students demonstrate outstanding innovation capacity. In the past five years, in the interdisciplinary field of medicine, engineering, and information technology, students have won more than 300 provincial-level and above awards in innovation and entrepreneurship competitions such as the Internet+ Competition, Challenge Cup, Service Outsourcing Competition, and CCPC, including 130 national-level awards. They have obtained 17 national and multiple provincial innovation projects and 6 patents. More than 30 research papers have been published in medicine, artificial intelligence, knowledge graph, big data and other related fields, among which 13 are SCI indexed.

Interdisciplinary integration of medicine and multiple disciplines has become an irresistible trend. Faced with increasingly complex medical scenarios and prominent demands for personalized medicine, innovative talents capable of creatively solving clinical medical problems are urgently needed. Cultivating innovative talents for the New Medicine Initiative through interdisciplinary integration of medicine, engineering and information technology will surely boost the rapid development of the intelligent healthcare era.

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