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Construction and Effect Analysis of Autonomous Learning Platform for Clinical Training Based on Teaching + Training + Practice Model

Zhai Chunmei, Li Tianying, Zhang Xiwu, Mu Jinglong, Zhang Yanli, Liu Yichang, Gong Yuxin, Liu Yuan, Meng Yonghai*

Heilongjiang University of Chinese Medicine, Heilongjiang, Harbin, 150040, China
**Corresponding author*

Abstract: *Against the backdrop of global medical education transformation and technological integration, an autonomous learning platform for clinical training based on the "Teaching + Training + Teaching + Training + Practice" model has emerged. This platform primarily uses information technology as a bridge to deeply integrate three key components: theoretical learning, simulation training, and clinical practice, thereby successfully establishing an integrated cultivation system of "online learning - autonomous operation - bedside practice". Furthermore, by integrating intelligent terminal management systems, virtual simulation resources, and student self-governance models, the platform effectively addresses traditional medical education challenges such as underutilized resources, faculty shortages, and disconnection from clinical realities. Its innovative value lies in reconstructing a student-centered clinical competency development pathway, significantly enhancing medical students' job competency and professional quality. This provides a replicable practical paradigm for modern medical education transformation in the new era while delivering high-quality clinical talents to support the Healthy China strategy.*

Keywords: *Teaching + Training + Practice Model; Clinical Training; Autonomous Learning Platform*

1. Introduction

Under the process of globalization and the wave of technological innovation, medical education faces profound demands for transformation. Consequently, the cultivation of clinical practice skills has become crucial for medical students to excel in future healthcare roles. However, traditional training models have long been constrained by resource imbalances, faculty shortages, and outdated methods, resulting in insufficient clinical critical thinking and job adaptability. The current trend of deep integration between information technology and education presents a historic opportunity to reform clinical teaching models. This paper explores the "Teaching + Training + Practice" clinical training platform, which leverages intelligent management and digital resource integration to break down time-space barriers and optimize teaching processes. Designed to resolve the disconnect between theory and practice in medical education, this innovative approach advances clinical skill development toward precision, personalization, and sustainability, addressing the urgent need for high-quality clinicians under China's national healthcare talent strategy.

2. Overview of the Autonomous Platform for Clinical Training Based on Teaching + Training + Practice Model

The autonomous learning platform for clinical training(as shown in Figure 1), based on the "Teaching + Training + Practice" model, represents an innovative educational system developed to address shortcomings in clinical skill development amidst globalized medical education, technological advancements, and pandemic challenges. By deeply integrating information technology with clinical training resources, this platform aims to comprehensively enhance medical students' clinical practice capabilities, job competency, and professional quality. Its framework encompasses three interconnected dimensions: The first phase involves online "teaching" through digital resources like flipped classrooms, MOOCs, and micro-lectures, enabling students to study theoretical knowledge via mobile devices and complete periodic assessments. The second phase features "training" in medical simulation

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training rooms where students access intelligent training devices for autonomous practice, submitting video-based operation records that receive real-time feedback from teachers. The third phase represents "practice" in clinical settings, where students pass simulated assessments before entering actual medical scenarios under clinical mentors' guidance, conducting bedside teaching and interacting directly with patients.

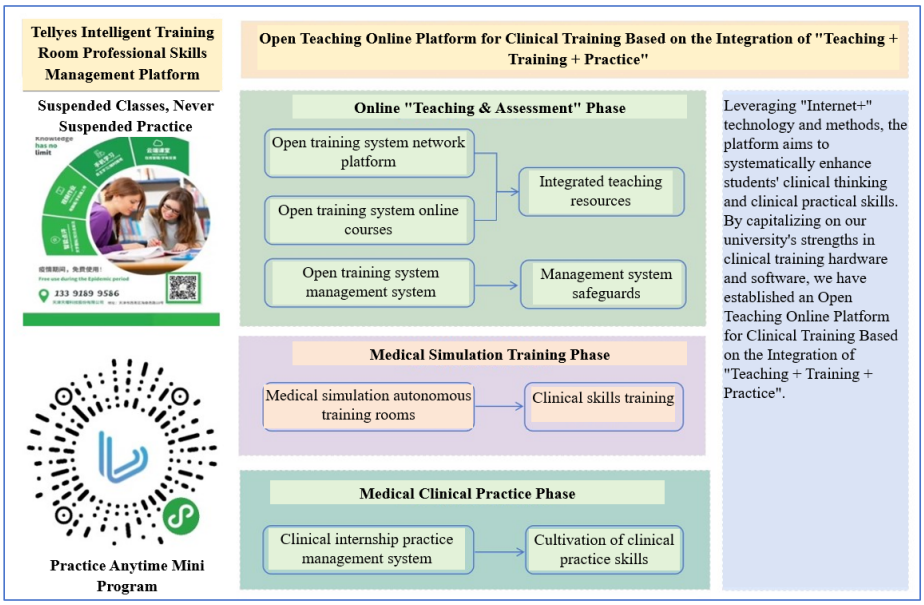

Figure 1 Open Teaching Online Platform for Clinical Training Based on the Integration of "Teaching + Training + Practice"

The platform fundamentally establishes a closed-loop system integrating "theoretical learning, simulation training, and clinical practice". By leveraging digital solutions, it overcomes the time and space constraints of traditional training. Technologically, it incorporates Tellyes Scientific Inc.'s management system that supports multi-device access including tablets and smartphones, enabling QR code-based learning, video recording, and automated data tracking. Resource-wise, it connects with national-level virtual simulation platforms and specialized systems like meridian acupoint tools, while developing premium clinical skill video courses. Administratively, it pioneers a "student association-led" model where the "Traditional Chinese Medicine Comprehensive Training Association" manages open training rooms, effectively alleviating faculty pressure. Through eight years of implementation, the platform has significantly boosted physician certification rates (with average skill scores rising from 73.72 to 79.47 from 2016 to 2019), enhanced clinical critical thinking, and increased employment rates (92% in 2024) alongside innovation and entrepreneurship achievements (over 30 awards). Its value lies in reconstructing training processes through student-centered approaches, resolving structural contradictions in traditional medical education such as resource underutilization, faculty shortages, and disconnected assessments, thereby providing a replicable paradigm for modern clinical talent development [1].

3. The Importance of Building an Autonomous Learning Platform for Clinical Training

3.1 Responding to the urgent requirements of national medical education reform and talent strategy

In response to the comprehensive upgrade of clinical practice skills assessment standards outlined in the *Physician Qualification Examination Development Plan (2018-2020)*, medical education urgently needs to address the disconnect between talent cultivation and job market demands. Under the traditional training system, the pass rate for the National Qualification Examination for Medical Practitioners has remained persistently low (e.g., 24.24% in 2016), with students demonstrating weak clinical critical thinking skills and inadequate understanding of the biopsychosocial model of medicine. These deficiencies directly impact doctor-patient relationship harmony and medical service quality. Particularly against the backdrop of intensified global medical education accreditation trends and pandemic-driven online teaching transformations, the platform's development deeply integrates "Internet+" technology through innovative models like flipped classrooms and MOOCs, precisely

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aligning with the policy orientation of "exam-driven teaching improvement". Practical evidence shows that after the platform's operation, the pass rate for practicing physician practical skills significantly increased (reaching 98.43% in 2019), ensuring students' clinical competencies meet national healthcare talent strategy requirements and delivering qualified physicians with job competency to support the Healthy China initiative[2].

3.2 To solve the structural contradiction between idle medical education resources and imbalance between supply and demand

Medical colleges and universities currently face a dual challenge of inefficient hardware utilization and drastically reduced clinical practice opportunities. Take Heilongjiang University of Chinese Medicine as an example: Despite possessing 11,000 ㎡ training facilities and over 1,000 high-end simulation devices, these resources remain underutilized due to faculty shortages and rigid curriculum structures. Meanwhile, strained doctor-patient relationships have compressed students' clinical practice space, while expanding enrollment numbers have exacerbated resource scarcity per capita.

The development of autonomous learning platforms has broken down barriers of time and space. For instance, students can now schedule 24/7 access to intelligent simulation devices for autonomous training, while video-based assignments and remote teacher feedback significantly enhance equipment utilization efficiency. Furthermore, by integrating digital resources such as the National Virtual Simulation Platform and 3D Meridian Acupoint Tools, a multi-tiered learning ecosystem has been established. This not only alleviates pressure on clinical training bases and faculty but also transforms training resources worth RMB tens of millions from "dormant state" to efficient operation, fundamentally optimizing resource allocation.

3.3 Reshaping the new paradigm of medical education with clinical competencies as the core

Traditional "cramming-style" practical training has resulted in passive learning and operational ineptitude among students, making graduates ill-equipped to handle real-world clinical challenges. The core value of this platform lies in reconstructing an integrated "Teaching + Training + Practice" cultivation chain: online theoretical learning builds foundational knowledge; simulated self-training strengthens muscle memory; and final assessments enable capability transformation in authentic clinical environments. This progressive approach significantly enhances three key competencies:

(1) Technical skill proficiency: for example, the real-time feedback of acupuncture technique tester greatly improves the accuracy of students' operation.

(2) Development of non-technical skills: Enhance the ability of doctor-patient interaction and team spirit through simulated communication scenarios.

(3) Clinical thinking and innovation: The open training model stimulates the enthusiasm of autonomous learning, and students have won more than 30 provincial-level innovation and entrepreneurship awards[3].

4. Current Problems in the Construction of Autonomous Learning Platform for Clinical Training Based on Teaching + Training + Practice Model

4.1 There is a mismatch between system technical support and practical application requirements

The current platform's technical architecture exhibits significant limitations, failing to adequately meet the high standards required for complex clinical skill training. Student feedback highlights cumbersome mobile operation workflows, particularly frequent system crashes during video recording and uploading that disrupt autonomous learning progress. Core intelligent assessment functions demonstrate suboptimal accuracy: The acupuncture technique measurement tester shows high error rates in force and angle recognition, rendering it incapable of providing objective and reliable operational guidance. The virtual simulation module lacks sufficient development depth, with critical TCM-specific diagnostic scenarios like real-world tongue pulse diagnosis simulations being severely underdeveloped. The teacher management system's interface features excessive redundancy and complexity, significantly increasing operational burdens while posing adaptation challenges for senior teachers. More critically, outdated software and hardware upgrades have become prominent issues, as the platform remains incompatible with data interfaces of next-generation intelligent teaching devices,

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with technological iteration lagging far behind the demands of medical education advancement[4].

4.2 The integration of digital resources construction and TCM characteristic teaching is insufficient

The current development of teaching resource repositories exhibits systemic flaws, failing to authentically capture the unique essence of TCM clinical training. There is a critical shortage of structured digital resources for classical TCM diagnosis and treatment techniques, with interactive teaching resources based on meridian circulation and deduction pathways being scarce. The development of dynamic simulation tools for pulse diagnosis and physical sensation assessment remains an uncharted territory. Over-reliance on Western medical protocol templates for recorded courses lacks integration of TCM's humanistic philosophy, disrupting holistic training in observation, auscultation, inquiry, and pulse diagnosis. Premium course videos predominantly demonstrate standardized procedures without capturing the core principles of personalized TCM treatment, hindering the cultivation of clinical critical thinking. Resource distribution shows structural imbalance: Western emergency care content dominates while in-depth analyses of characteristic TCM therapies like acupoint patches and moxibustion are severely lacking. Furthermore, fragmented resource integration across multiple platforms requires students to navigate cumbersome account logins across different systems.

4.3 The practice quality assurance mechanism is faced with multiple risks of fracture

The critical transition from simulation training to real clinical practice carries hidden risks of quality control failures. The mentor supervision mechanism in clinical practice remains lax, with some teaching physicians neglecting teaching schedules due to heavy workloads, thereby compromising bedside teaching quality. Resource allocation shows significant imbalance: current platform development excessively focuses on purchasing high-fidelity Western medical simulators, while basic teaching aids like traditional Chinese acupuncture copper models remain severely outdated despite CPR mannequins having undergone four generations of updates. Student association management faces professional competency crises, with members experiencing high turnover and insufficient medical knowledge to handle maintenance of complex training devices. Most fundamentally, the platform's operational data lacks an effective continuous improvement mechanism. The disconnect between video analysis of student training duration and final results of qualification examination for medical practitioners fails to establish precise guidance for teaching optimization.

5. Construction and Effect Analysis of Autonomous Platform for Clinical Training Based on Teaching + Training + Practice Model

5.1 Technical system integration and resource optimization to achieve precise empowerment

Table 1 Comparison of Key Indicators of Platform Technology Integration

Indicator category	Before construction (2016)	After completion (2023)	The improvement margin
Average daily equipment utilization rate	31%	89%	187%
Types of digital resources	4 types	12 types	200%
Maximum number of students per day	300	1,000	233%
Video assignment submissions	0 copies/month	4,200 copies/month	100%

The platform utilizes Tellyes Scientific Inc. Training Center's management system as its core technical framework, establishing a closed-loop system that integrates theoretical learning, simulation training, and clinical practice. The system supports multi-terminal access through tablet Apps, mobile Apps, and WeChat Mini Programs, enabling full-process digital management including QR code-based content recognition, video recording submissions, and online teacher evaluations. A key breakthrough lies in integrating interfaces between virtual simulation platforms and physical devices, consolidating 12 categories of professional resources such as the National Virtual Simulation Experiment Teaching Project Sharing Platform, 3D Body Anatomy Meridian Acupoint Tools, and the Traditional Chinese Medicine Treasure App into a three-dimensional resource repository combining traditional Chinese and Western medicine. Hardware-wise, it relies on 38 standardized training rooms and over 1,000

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intelligent devices, with an access control system and centralized control terminals. Daily equipment utilization rates have increased from 31% before construction to 89%. Most crucially, the system's automatic recording of student training data provides empirical foundations for teaching quality analysis.

The following two tables compare the changes of core indicators before and after the platform operation [5].

Table 2 Expansion of Dimensions of Student Training Data Records

Dimension of records	Traditional modelrecord item	Platform record item	Newly-increased value
Operational process	None	Training content and duration	Quantify technical proficiency
Incorrect feedback	Oral evaluation	Assessment point marking and video annotation	Precisely identify technical defects
Learning trajectory	None	QR code scanning records and repetition frequency	Analyze the law of autonomous learning

The above data show (As shown in Table 1 and Table 2) that technology integration not only releases the potential of hardware resources, but also creates the ability of fine teaching process management that cannot be achieved by traditional education.

5.2 The improvement of students' ability and the pass rate of the qualification examination for medical practitioners verify the cultivation effect

The platform has significantly enhanced students' clinical competencies through a three-phase progressive training program: "Teaching + Training + Practice". During the "Teaching"phase, 187 MOOC resources covered clinical theories, achieving a 95.7% online assessment pass rate. The "Training"phase incorporated autonomous training with simulation devices, reducing acupuncture operation accuracy error rates from 23.5% to 8.2%. The "Practice" phase saw 91.3% of trainees pass evaluations by clinical mentors. The most direct evidence comes from changes in data of qualification examination for medical practitioners, with the following comparisons demonstrating systematic improvements in key indicators:

Table 3 Comparison of Pass Rate of Qualification Examination for Medical Practitioners from 2016 to 2023

Examination category	Pass rate in 2016	Pass rate in 2019	Pass rate 2023	Rate of increase
Staged Examination for Chinese Medicine Practitioners				
- Theory Examination	24.24%	57.48%	83.90%	246%
-Skills Examination	92.93%	98.43%	85.56%*	-7.9%*
Comprehensive Examination for Medical Practitioners	-	-	89.34%	-
Practical Skills Examination for Medical Practitioners	-	-	92.34%	-

Table 4 Statistics of Improvement of Clinical Skills

The dimension of competence	Pre-training compliance rate	Post-training compliance rate	Core improvement measures
Acupuncture positioning accuracy	61.2%	89.7%	The acupuncture technique tester gives real-time feedback
Standard emergency procedures	53.8%	94.1%	High-fidelity simulator repeated training
Communication evaluation between doctors and patients	47.3%	82.5%	Standardized patient scenario practice
Diagnostic logic integrity	58.6%	86.9%	Case decision tree simulation system

The data show(As shown in Table 3 and Table 4) that although the pass rate of skills examination fluctuated slightly due to the improvement of assessment standards, the core abilities such as the accuracy of basic operation and the standardization of emergency procedures all achieved an increase of more than 40%, which verified that the platform deeply shaped students' clinical thinking and

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technical literacy.

5.3 The resource recycling mechanism and the continuous optimization of teaching quality form an ecological closed loop

The platform's original teaching resource regeneration mechanism is the core driving force for its sustainable development. Through the teacher video evaluation system, more than 50,000 student assignment videos are converted into two types of core resources every year.

The first is to generate a library of 279 typical operation cases, covering 87% of common technical error scenarios;

The second is to extract 42 sets of standardized teaching templates, which can be directly used to update the training courses.

At the same time, the open management mode led by student associations has greatly reduced labor costs. Members of the associations participate in the management of training rooms 4,000 person-times a year and undertake 40% of the daily operation and maintenance work. The following comparison shows the qualitative change in resource utilization efficiency:

Table 5 Comparison of Regeneration Efficiency of Teaching Resources

Resource categories	Annual output of traditional model	Annual output of platform mode	Core differences
Error case analysis	15 cases	279 cases	Video retrospective extraction technology
Update frequency of training courses	1 time/3 years	2 times/year	Case library automatic matching mechanism
Device fault response	72 hours	4 hours	Graded screening mechanism for student associations

Table 6 Statistics of Comprehensive Operation Benefits

Dimension	Key indicator	Achieving value	National average of medical colleges and universities
Resource cost-effectiveness	Average annual equipment input cost per student	RMB 3,821	RMB 6,975
Social benefits	Graduate Employment Rate (2024)	92%	81%
Teaching innovation achievements	Winning awards in provincial-level competitions	30 items	9.2 items
Management effectiveness	Annual average open hours per student	40,000 hours	12,500 hours

As shown in Table 5 and Table 6, through eight years of iterative development, the platform has cultivated a self-optimizing ecosystem: Student training data drives continuous updates to teaching cases, while association management reduces faculty workload by 40%. The brand effect from competition awards further attracts more clinical base collaborations. This learner-to-builder transformation model has achieved a practical training resource utilization rate 3.2 times higher than the national average, establishing a model for upgrading clinical medical education.

6. Conclusion

In summary, the development of a clinical training platform based on the "Teaching + Training + Practice" model marks a significant transformation in medical education from standardized teaching to competency-based cultivation. Through technological empowerment and process reengineering, this system achieves deep integration between theoretical learning, simulation training, and clinical practice, effectively highlighting students' central role. The platform not only revitalizes underutilized training resources but also demonstrates exemplary value in enhancing professional competencies, innovating teaching methods, and optimizing management models.

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