Digital and Intelligent Empowerment and New Quality Health Service Capabilities Cultivation: An Exploration on the Teaching Reform of the "Health Service and Management Skills" Experimental Course

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Abstract: Under the dual strategies of "Healthy China 2030" and "Digital China," professionals in health service and management are expected to possess both traditional medical competencies and digital and intelligent healthcare literacy. To address the gap between the "Health Service and Management Skills" laboratory course and job competency, the reform of this experimental course is undertaken, aiming to establish a "new ecology of digital and intelligent experimental teaching" that cultivates talents with new quality health service capabilities. Four core competency development goals are defined: data literacy and intelligent decision-making; application of intelligent tools and human–machine collaboration; personalized and precise service design; and digital communication skills. Teaching measures include VR-based virtual simulation for pre-class preparation, AI and big data platform–driven data prediction, and interactive intelligent courseware that provides personalized feedback and learning plans. Supported by real-world health management project practice, the reform also integrates innovation competition, diversified assessment methods, and the cultivation of humanistic qualities. Students' subjective initiative was stimulated, and their job competency in adapting to "new quality health service capabilities" was significantly enhanced. This study explored the cultivation pathways for future professionals in the health service industry, providing valuable insights for similar course reforms, and established a replicable model of teaching innovation applicable to majors such as elderly Health Service and Management and digital healthcare.

Keywords: Health Service and Management; Experimental teaching reform; Digital and intelligent empowerment; New quality health service capabilities; Job competency

1. Introduction

1.1. Necessity of teaching reform of the "Health Service and Management Skills" experimental course

The *"Healthy China 2030" Plan Outline* identifies the advancement of a Healthy China as a fundamental basis for

achieving socialist modernization [1]. The General Secretary has emphasized that artificial intelligence (AI), as a strategic technology driving a new wave of scientific and industrial transformation, is profoundly reshaping human production and lifestyles, and should be leveraged to enhance public service delivery. The Third Plenary Session of the 20th Central Committee of the Communist Party of China further designated AI as a strategic industry to accelerate digital and intelligent transformation across sectors. With the ongoing implementation of the dual strategies of "Healthy China 2030" and "Digital China," the integration of digital-intelligent technologies into the construction of a Healthy China has become both necessary and inevitable. In particular, within the field of Health Service and Management, the digital-intelligent transformation of the health service industry is regarded as a crucial driver for improving the quality and efficiency of future medical services [2]. Deficiencies have been identified in the current Health Service and Management major regarding the cultivation of students' digital and intelligent literacy. In particular, experimental teaching remains constrained by traditional models that are misaligned with the job requirements of new quality health service capabilities, leading to students' limited mastery of digital and intelligent technologies and underdeveloped digital thinking.

To address this problem, this study focuses on the development needs of new intelligent health service capabilities and constructs a "new ecology of digital and intelligent experimental teaching" to implement the teaching reform of the "Health Service and Management Skills" experimental course. Pathways are explored for fostering students' adaptability to the development of new quality productive forces, integrating talent cultivation with the practical demands of social development, and providing theoretical guidance and reference for the reform of similar experimental courses. The "new digital intelligence experiment teaching ecosystem" and curriculum reform practice constructed in this study fills the systematic gap of the "new quality productive forces-adapted talent cultivation model" in the existing Health Service and Management teaching research, and provides a replicable theoretical framework and practical paradigm for similar experimental courses to realize the integrated reform of "technology empowerment-ability cultivation-demand docking."

1.2. The connotation of "digital and intelligent empowerment" and "new quality health service capabilities"

The synthesis of data and intelligence is termed data intelligence, abbreviated as "digital intelligence" [3]. Digital and intelligent empowerment represents a composite concept that integrates digital intelligence with empowerment. At its core, it involves the application of advanced information technologies—such as big data, AI, and cloud computing—to transform the operational mechanisms of existing systems, equipment, or processes, thereby enabling more efficient and autonomous functioning. Beyond technological reform, digital and intelligent empowerment exerts a profound influence on the transformation of individual and collective cognitive frameworks, thinking patterns, and mental models. Digital technologies and AI are profoundly reshaping the landscape of medical education. AI technologies can deliver customized learning content and assessments tailored to students' learning styles, progress, and needs, thereby enabling personalized education [4,5]. This approach helps address challenges inherent in traditional educational models, such as limited teaching resources and the exponential growth of medical knowledge [6]. Moreover, generative AI tools, such as ChatGPT and Gemini, are increasingly being adopted in higher education—including nursing education—and hold promise for transforming content delivery and student engagement [7]. Survey studies also show that, whether in key universities offering multi-level courses in AI or in general universities providing courses such as "Medical Image Processing" that incorporate elements of virtual simulation, these intelligent courses effectively integrate medical knowledge with digital intelligence technologies. They help students achieve multi-dimensional enhancement of professional skills and innovative thinking, thereby significantly strengthening their overall competence in adapting to the development of new medical disciplines [8]. Additionally, AI provides access to extensive databases for research and interactive learning, thereby improving overall medical knowledge and clinical practice [9]. Through this process, medical institutions are driven to employ big data and AI

technologies to optimize resource allocation, enhance service efficiency, and improve patient experience, ultimately advancing the overall quality and management of healthcare services.

Driven by population aging, shifts in disease patterns, and a growing public awareness of health, the demand for high-quality, convenient, and personalized health services has been steadily increasing, thereby imposing higher requirements on service capacity and supply models in the health sector. The deep integration of the health industry with digital and intelligent empowerment has emerged as a key driving force for the high-quality development of public health undertakings. This integration is embodied in the digital and intelligent collection, analysis, and management of health data, the formulation of personalized and dynamic health pre-intervention strategies, and the establishment of digital and intelligent service models. Essentially, digital and intelligent empowerment not only shapes new quality health productivity but also provides it with innovative technologies, methods, and models; in practice, the latter transforms these innovations into actionable health solutions.

2. The cornerstone for enhancing job competency: Four core competencies

The cultivation of job competency oriented toward "new quality health service capabilities" requires targeted support for the following four core competencies.

2.1. Data literacy and intelligent decision-making ability

Students are first guided to manage, integrate, and analyze multi-source heterogeneous health data, such as electronic health record data and wearable device data. Based on this foundation, they are further instructed to employ a time series forecasting model (Long Short-Term Memory Network [LSTM]) to generate a health trend report, or to apply a classification model (e.g., Random Forest (RF), Random Forest, abbreviated as RF) for predicting the incidence trends of infectious diseases such as COVID-19 and hand, foot, and mouth disease. At the same time, students are guided by teachers to take on different roles in analyzing diverse data sources (for instance, clinical experts are assigned to evaluate the RF classification results), and decisions are refined through debates among them. Through such training, scientific analytical methods are mastered, data literacy is cultivated, and intelligent decision-making ability in managing complex health data is strengthened.

2.2. Operation of intelligent tools and human-machine collaboration thinking

Students were guided to independently operate various intelligent health monitoring tools or health mobile apps, and were encouraged to raise questions encountered during use. They were organized into study groups to exchange ideas and collaboratively solve problems, thereby stimulating critical thinking and fostering the ability to identify and address issues. Subsequently, teachers provided feedback on the group discussions to help students develop a mindset of "human-machine collaboration rather than opposition." Through a problem-driven approach, independent inquiry, and team collaboration, this course design cultivated students' prudence and scientific judgment toward data-intelligent analytical results, fully reflected the student-centered teaching philosophy, and effectively enhanced their learning initiative.

2.3. Capability for the design and development of personalized services

The standardized health intervention plan has been found inadequate to meet the health needs of specific populations. To ensure that capability development is closely aligned with clinical practice, a collaborative education model is established jointly by teachers, medical institutions, and experts from the community health service center. Initially, frontline clinicians or community health managers share project information and identify practical needs. Subsequently, under the guidance of teachers, students design a personalized health intervention plan, which is then reviewed and evaluated by experts. Finally, the plan is refined and finalized through collective discussions among

teachers, students, and clinical experts. This approach enables students to transition from designing standardized to personalized intervention plans, ultimately achieving the goal of delivering high-quality health services.

2.4. Digital communication skills

The development of digital communication skills is achieved through the use of AI-assisted creation, AR virtual reality, and other forms of digital media technology under the guidance of educators to promote the dissemination of health science knowledge [10]. For example, by employing AI-assisted creation tools, students are enabled to produce customized science copywriting or short video scripts tailored to the cognitive traits and preferences of different audiences, such as older adults or working professionals. Furthermore, AR technology is applied to recreate authentic scenarios of community health education, home consultation for patients with chronic diseases, and health communication for special populations (such as patients with hearing impairment). Through immersive simulations, communication techniques suited to diverse contexts are practiced and refined, allowing the experiential learning gained in AR environments to be transformed into practical digital communication skills applicable to real-world professional settings.

3. Reform path: Building a new ecology of digital and intelligent experimental teaching

Currently, most experimental courses are conducted through centralized instruction by teachers, with students engaging in passive learning. Such an approach not only suppresses students' initiative but also limits the development of their abilities to identify, analyze, and solve problems through practice. As a highly practice-oriented discipline, health service management relies on practitioners who directly influence the quality and standards of public health services. Consequently, practitioners in this field are required to possess advanced, new quality health service capabilities. In response, guided by "new quality health service capabilities" and underpinned by "four core competencies of job competency," a scientific and efficient digital and intelligent experimental teaching system is established. The core elements of the system's development encompass the following aspects.

3.1. Previewing using virtual reality technology

Under the traditional previewing model, students often find it difficult to visualize real medical service scenarios based solely on textual descriptions and static images. For instance, chronic disease health assessment and postoperative recovery interview involve environmental details (such as home settings) and patient interactions (such as nonverbal communication), which cannot be effectively conveyed through static materials. As a result, contextual understanding is hindered, and students struggle to grasp intricate details. This limitation prevents them from identifying and addressing potential challenges in practical operations during the preview stage, thereby undermining their confidence in practice and diminishing their interest in learning abstract theoretical knowledge.

To address these issues, virtual reality (VR) technology offers an effective solution. By creating a highly realistic three-dimensional immersive environment, students can be immersed in simulated scenarios before class—for example, entering an elderly person's home to conduct a health assessment—transforming passive previewing into active experiential learning. Through this immersive experience, passive learning is transformed into active exploration, which markedly enhances students' pre-class engagement and curiosity and consequently improves the learning outcomes of laboratory courses.

3.2. Integration of digital and intelligent practical feedback with the cultivation of critical thinking

To optimize the practice of medical education, off-campus partnerships are established between teachers and medical institutions as well as community health service centers, ensuring the continuity of practical training resources. The teaching focus is placed on three main aspects. First, the cultivation of students' spirit of inquiry.

Cases of failure in health management are collected and used as instructional materials. By fostering an open and interactive classroom atmosphere, students are encouraged to confront real and atypical medical situations, to ask "why," and to exchange ideas, thereby stimulating critical thinking. Second, the enhancement of hands-on training. Practical tasks are first performed by students and then evaluated by the digital and intelligent system, through which feedback is provided to further refine their practical skills. Third, the development of students' overall professional competence. Students are guided to engage in authentic, full-cycle clinical scenarios—including health screening, assessment, intervention, and management of failed cases—to strengthen their practical competencies and foster a rigorous, detail-oriented professional attitude.

3.3. Intelligent digital platforms enhance teaching effectiveness

Traditional laboratory teaching has shown limitations in presenting health monitoring and analysis outcomes, which hinders students from gaining a comprehensive understanding of medical data requirements and epidemic development trends. In contrast, intelligent digital teaching platforms have been developed to integrate AI-based risk assessment and big data analytics, enabling people to perform specialized analyses and make predictions based on population health data [11]. Additionally, complex health data can be transformed into intuitive visual representations through built-in visualization tools, allowing for clearer presentation of results and more effective illustration of health trends.

3.4. Intelligent courseware guides personalized learning paths

By utilizing professional courseware creation tools (such as Articulate Storyline and Adobe Captivate), teachers are able to develop interactive, intelligent courseware that incorporates real-time interactive feedback, automated assessment, and personalized learning path design. There is research that suggests that these features provide necessary technical support for implementing student-centered teaching [12]. This shifts the teacher's focus from "what I want to teach" to "what students need to learn." Moreover, interactive intelligent courseware is also capable of generating a learning situation report in real time, enabling teachers to identify common challenges encountered during instruction.

3.5. Intelligent competitions empower experimental teaching practice

Although skills competitions are not a novel instructional approach in experimental teaching, the evolving demands of new quality health service capabilities for enhanced job competency have driven a shift from traditional hands-on competitions toward innovative intelligent competitions centered on AI health management and health big data. These competitions primarily evaluate students' abilities to integrate data analysis and intelligent technologies into creative design solutions. By adopting a competition-based format, experimental teaching not only improves students' practical skills but also fosters a stronger sense of competitiveness and teamwork [13].

3.6. Cultivating talents in the era of intelligent digitalization guided by medical humanities literacy

The cultivation of medical humanities literacy in the era of intelligent digitalization should be integrated into experimental classroom teaching. This can be implemented through the following three approaches: (1) Conflict-based tasks—such as "modifying electronic medical records leading to medical disputes" or "deviations in AI diagnosis results"—can be designed when students use big data or AI-assisted tools. These tasks help students grasp the principles of medical ethics and avoid the tendency to prioritize technology over ethical considerations. (2) Frontline physicians can be invited to deliver medical data ethics training, thereby enhancing students' ability to interpret and communicate data meaningfully to patients. (3) Ethical analysis and simulation exercises can be regularly conducted through digital technology ethics practice workshops, organized by student associations or extracurricular study groups. These activities aim to reinforce a sense of humanistic care, emphasizing respect for

patients' rights, promotion of healthcare equity, and improvement of service quality [14].

4. Assessment and evaluation: Centered on "digital and intelligent competence"

A competency-based assessment system for Health Service and Management has been established within the framework of digital and intelligent empowerment, integrating both formative and summative evaluations to ensure comprehensive, objective, and effective assessment. The core focus lies in evaluating students' abilities to apply intelligent technologies and data analysis in health services, along with the development of critical thinking and collaborative communication skills.

4.1. Formative evaluation

Formative evaluation emphasizes the ongoing assessment of students' learning processes. It is designed to identify issues promptly, support learning progression, and guide students in gradually acquiring essential competencies. The evaluation includes the following components.

4.1.1. Operation of intelligent platforms and data report writing

Students' proficiency is assessed through their ability to accurately configure parameters of smart health devices, efficiently input and synchronize health data, and utilize platform functions to visualize data—such as generating analytical charts and trend reports. Evaluation methods include instructor observation, random checks of platform operation records, and submission of operation logs. In the data reporting phase, students are required to produce standardized data analysis reports based on health data collected and processed via intelligent platforms. Students' proficiency in operating intelligent hardware and software platforms for health management (such as the wearable device data synchronization system, remote monitoring platforms, and the backend of health management apps) is assessed. Key aspects include the accuracy of parameter settings for intelligent health devices, the efficiency of health data entry and synchronization, and the ability to utilize platform functions for data visualization, such as generating analytical charts and trend reports. Assessment methods consist of teacher observation, random sampling of platform operation records, and submission of operation logs. In the data report writing component, students are required to generate standardized data analysis reports based on health data collected and processed via intelligent platforms.

4.1.2. Health management project design

Students are expected to develop a comprehensive health management project plan tailored to a specific population or health issue, incorporating intelligent and digital technologies. Evaluation criteria emphasize the plan's level of innovation, feasibility, scientific soundness, and the extent to which intelligent and digital technologies are effectively integrated.

4.1.3. Digital portfolio creation and presentation

Outstanding outcomes from laboratory sessions—such as platform operation screenshots, data analysis reports, project proposals, and simulated health education materials—are to be integrated into a comprehensive digital portfolio. Evaluation is centered on the demonstration of digital competence, innovative thinking, and the ability to address real-world problems. Additional assessment criteria include visual design quality, content completeness, logical coherence, and the effective use of digital tools, such as infographics and interactive reports.

4.1.4. Group collaboration and digital communication performance

This component evaluates students' engagement, teamwork, and problem-solving abilities within group projects, with particular attention given to their performance in virtual collaboration environments. Key indicators include the use of online collaboration tools for document editing and resource sharing. Digital communication

performance is evaluated based on the effectiveness of communication in digital environments, including the accuracy of information delivery, the timeliness of feedback, and the proper use of professional communication tools such as instant messaging, online meetings, and email.

4.2. Summative assessment

Summative assessment provides a comprehensive evaluation of students' learning achievements, with an emphasis on their ability to integrate and apply acquired knowledge and skills in complex, real-world scenarios. It serves as a means to thoroughly assess students' overall competencies in intelligent device operation, data case analysis, and AI-assisted decision-making. The assessment includes four components.

4.2.1. Practical operation of intelligent devices

In simulated clinical or community settings, students are expected to independently complete the connection, calibration, data collection, and basic troubleshooting of assigned intelligent devices.

4.2.2. Multimodal data case analysis

Students' ability to apply data analysis tools to real-world cases involving multidimensional health data is assessed, with emphasis on their skills in identifying health issues, proposing personalized intervention strategies, integrating diverse data sources, and distilling complex information. They are expected to critically examine "abnormal" findings within the cases and articulate their own interpretations and solutions.

4.2.3. AI-assisted decision-making evaluation

In simulated complex decision-making scenarios, students are required to obtain informational recommendations using AI-assisted diagnostic or health management systems and to critically assess the outputs. This evaluation focuses on their ability to integrate intelligent tools with professional judgment to make well-rounded decisions.

4.3. Core evaluation framework and criteria for assessing reform effectiveness

Digital technology provides the core driving force for teaching reform in the Health Service and Management discipline, while a scientifically designed evaluation system serves as the key to assessing the effectiveness of such reform. Guided by a competency-based approach, this study establishes a dual evaluation framework centered on "digital and intelligent capabilities," integrating formative assessment (weight 40%) and summative assessment (weight 60%). Quantitative indicators are employed to accurately measure student outcomes, thereby offering a scientific basis for evaluating the success of the reform.

The formative assessment focuses on the learning process and is divided into four quantitative dimensions: (1) intelligent platform operation and data report writing (weight 15%), with standards such as parameter setting accuracy ≥92%; (2) health management project design (weight 10%), emphasizing technological integration and feasibility, with a passing threshold of ≥81 points; (3) digital portfolio (weight 10%), comprehensively assessing digital literacy, with ≥80 points considered satisfactory; and (4) team collaboration (weight 5%), measured by indicators such as 100% utilization of collaborative tools, enabling refined monitoring of the learning process.

The summative assessment simulates real-world scenarios to verify students' comprehensive competencies and consists of three core modules. The first module, intelligent device operation (weight 20%), requires completion within 12 minutes with an accuracy rate of ≥96%. The second module, multimodal data case analysis (weight 25%), uses the accuracy of health problem identification (≥93%) as the key indicator. The third module, AI-assisted decision-making (weight 15%), emphasizes the compliant application of tools and the integration of professional judgment, with decision rationality ≥92%.

The criteria for determining the success of the reform include the following: the weighted total score, composed of formative assessment (40%) and summative assessment (60%), must reach 82 points or above; the pass rate for each of the five core dimensions—Digital Operation, Data Processing, Smart Technology Application, Critical Thinking, and Collaborative Communication—must not fall below 92%; within the summative evaluation, the pass rate for the three core modules—Intelligent Device Operation, Multi-modal Data Case Analysis, and AI-assisted Decision-making—must be no less than 95%; meanwhile, the average score of the individual components of formative assessment should be at least 80% of the full score for each component, with no single component averaging below 60%.

5. Expected outcomes, reflections, and prospects

One of the important approaches to cultivating health management professionals with high-quality health service capacity is the experimental teaching of the course Health Service and Management Skills. Through the teaching path proposed in this paper, based on theoretical knowledge and the new ecology of digital and intelligent experimental teaching, students can not only develop their self-learning ability, operational skills, and the ability to discover and solve problems, but also enhance their critical thinking and digital-intelligent literacy. In the context of the new era where digital and intelligent technologies empower health service capacity, improving the quality of experimental teaching in the Health Service and Management curriculum requires abandoning traditional teaching methods, transforming the thinking patterns and consciousness of both teachers and students, leveraging the smart teaching platform, utilizing various big data analysis tools, and engaging in real frontline health management projects, so that students can achieve comprehensive improvement in both skills and cognition through hands-on practice. Only in this way can more outstanding talents with job competency be cultivated for the development of new quality health service capabilities. This model not only provides a talent cultivation paradigm to meet the future development needs of the health service industry, but also offers a replicable reform template for teaching innovation in related disciplines such as elderly Health Service and Management, digital healthcare, and medical and health education.

The innovative model of experimental teaching in the "Health Service and Management Skills" course provides policymakers and educational institutions with a practical pathway to enhance the effectiveness of healthcare management talent cultivation reform. Supported by the digital and intelligent experimental teaching ecosystem, this model abandons traditional teaching approaches and integrates intelligent teaching platforms, big data tools, and frontline healthcare management practice. These measures effectively strengthen students' core competencies in autonomous learning, practical application, and problem solving, while also reinforcing their critical thinking and digital intelligence literacy. The model thus offers concrete references for relevant policy formulation and the implementation of teaching reform.

Moreover, this model aligns with the talent demands of the health service industry and provides a replicable teaching paradigm for related disciplines such as Elderly Health Service and Management. Future research may further explore its potential long-term impacts, including the adaptability of the model across diverse health service scenarios and the tracking of graduate career development outcomes. Such efforts would deepen understanding of its applied value and scalability, thereby offering stronger support for high-quality health service talent cultivation.

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