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Research on the Educational Model of Integrating Innovative and Entrepreneurial Education into Basic Medical Courses in Higher Vocational Colleges Under the Perspective of the Three-Education Reform

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Abstract

Under the background of vocational education reform in the new era, higher vocational medical education faces the important task of cultivating innovative and compound medical talents. Based on the framework of "three education reforms", this study combines innovation and entrepreneurship education with the concept of curriculum ideological and political education to construct a new model of "four-wheel drive, five-in-one" basic medical course education. A two-year teaching practice study shows that this model effectively improves students' theoretical knowledge application ability (improved by 23.5%), professional practical skills (improved by 31.2%) and innovation and entrepreneurship ability (competition winning rate increased by 40%). The study adopts a mixed research method. Quantitative data show that the pass rate of professional qualification examinations of students in the experimental class reached 92%. Qualitative analysis found that students' professional identity and innovation awareness were significantly enhanced. This study provides a theoretical framework and practical path for the reform of higher vocational medical education, and has important reference value for cultivating high-quality medical technical and skilled talents that meet the strategic needs of Healthy China.

Keywords

Three-education reform; innovation and entrepreneurship education; higher vocational medical education; curriculum ideological and political education; education model.

1. Introduction

With the advancement of policies such as the National Vocational Education Reform Implementation Plan (“Vocational Education 20 Articles”) [1] and the Opinions on Deepening the Reform of the Modern Vocational Education System [2], higher vocational education is transforming from scale expansion to high-quality development. As an important part of vocational education, medical education faces the demand for compound and innovative medical talents under the background of the new medical reform. However, traditional higher vocational basic medical courses still have problems such as focusing on theory rather than practice, single teaching methods, and insufficient integration of innovation and entrepreneurship education.

The “three-teaching reform” has provided new ideas for the reform of higher vocational medical education [3-5], but existing research has mostly focused on the single-point

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optimization of teachers, teaching materials, and teaching methods, lacking the exploration of a systematic education model. At the same time, the integration of innovation and entrepreneurship education with professional courses is still in its early stages and has not yet formed a practical paradigm that can be promoted. Therefore, based on the framework of the "three-teaching reform", this study combines innovation and entrepreneurship education with curriculum ideological and political education to construct a "four-wheel drive + five-in-one" basic medical course education model to enhance students' professional ability and innovation literacy.

In the key field of basic medical education, academic circles at home and abroad have shown active exploration and unremitting pursuit of efficient and innovative talent training models, aiming to adapt to the ever-changing medical environment and the urgent needs of industry development. At the domestic level, with the deepening of the "three teaching reforms" - teachers, teaching materials, and teaching methods, basic medical education is gradually breaking free from the constraints of traditional disciplinary boundaries and moving towards a teaching model with organ systems as the core. This transformation not only marks a profound reorganization and optimization of educational content, but also highlights the high importance attached to the cultivation of students' practical ability and comprehensive quality.

Specifically, the practical exploration of Liu Liming et al. (2022) in the course of Animal Anatomy and Histology and Embryology [6] is a vivid example of this transformation. By ingeniously integrating ideological and political elements into the course, they not only achieved the harmonious unity of knowledge imparting and value guidance, but also fully demonstrated the successful application of the "five-in-one" education concept in actual teaching. This innovative practice undoubtedly provides valuable experience and inspiration for the reform of basic medical education in China.

Foreign research, on the other hand, presents a different research focus, which pays more attention to the deep integration of interdisciplinary cooperation and digital technology. In many developed countries, basic medical education has generally adopted digital platforms, such as virtual laboratories, online courses and other advanced teaching methods, to effectively improve students' independent learning ability and practical operation skills. In addition, foreign universities also attach great importance to the integration of innovation and entrepreneurship education, and encourage students to actively cultivate innovative thinking and entrepreneurial ability on the basis of solid mastery of professional knowledge. This educational concept coincides with the views advocated by Li Yan et al. in China [7], and together they reveal the important position and role of innovation and entrepreneurship education in basic medical education.

Both domestic and foreign basic medical education research has shown active exploration of efficient and innovative talent training models, and each has its own characteristics and can learn from each other. In the future, with the continuous updating of educational concepts and the continuous advancement of science and technology, basic medical education will surely usher in a broader development prospect and a more far-reaching impact.

2. Theoretical Framework and Research Design

2.1. Definition and connotation analysis

The core concepts involved in this study need to be clearly defined and their connotations analyzed. First, as an important starting point for vocational education reform, the essence of the "three-teaching reform" is the systematic transformation and collaborative innovation of the three key elements of teachers, teaching materials, and teaching methods [8]. In this study, we deepened and expanded its connotation: at the teacher level, we focused on building a "dual-teacher" teaching innovation team with theoretical teaching ability and clinical practice ability;

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at the teaching material level, we focused on developing a new teaching material system that integrates "paper teaching materials + digital resources + loose-leaf manuals"; at the teaching method level, we comprehensively promoted the reform of the "online and offline hybrid" teaching model based on information technology.

Secondly, innovation and entrepreneurship education is defined in this study as including two interrelated dimensions: the first is the cultivation of innovation awareness, which focuses on the cultivation of students' critical thinking and innovative thinking, which belongs to the theoretical level of literacy improvement; the second is entrepreneurial practice training, which focuses on cultivating students' ability to transform innovative ideas into practical results, which belongs to the operational level of skill training. These two dimensions support each other and are organically unified, and together constitute the complete connotation of innovation and entrepreneurship education in this study.

2.2. Construction of the "Four-wheel Drive + Five-in-One" Education Model

Based on the above definition, this study constructed a "four-wheel drive + five-in-one" education theory model (see Figure 1). This model systematically integrates the core elements of the "three education reforms" and the key dimensions of innovation and entrepreneurship education to form an education framework with the characteristics of higher vocational medical education.

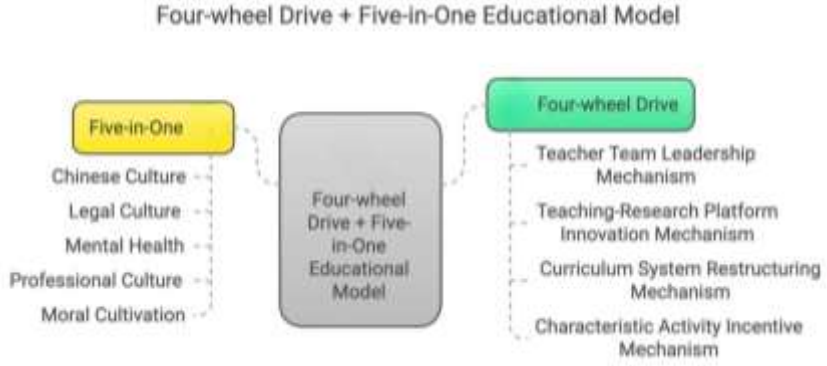

Figure 1: The "Four-wheel drive + Five-in-one" education theory model

In terms of operating mechanism, "four-wheel drive" constitutes the core power system of the model:

(1) Teacher team leadership mechanism: By forming a cross-border teaching team composed of professional teachers, clinical experts and entrepreneurial mentors, we can achieve collaborative education among multiple subjects. Among them, professional teachers are responsible for theoretical teaching, clinical experts strengthen practical guidance, and entrepreneurial mentors focus on innovative thinking training. The three complement each other's advantages and form a joint force for education.

(2) Innovation mechanism of teaching and research platform: Focus on the construction of digital teaching platforms including virtual simulation experiment center and online course platform to provide technical support for hybrid teaching. The platform construction follows the principle of "combining virtual and real, and being able to be real without being virtual", which not only ensures the teaching effect, but also pays attention to the efficiency of resource utilization.

(3) Curriculum system reconstruction mechanism: Establish a three-level curriculum module of "foundation + expansion + innovation". The basic module ensures the cultivation of professional core capabilities, the expansion module strengthens clinical practice capabilities,

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and the innovation module focuses on improving innovation and entrepreneurship capabilities. The three modules are progressive and organically connected.

(4) Special activity incentive mechanism: Through regular practical activities such as medical innovation design competitions and clinical skills competitions, students' learning interest and innovation potential are stimulated. Activity design focuses on the connection with professional courses to ensure the organic unity of theoretical teaching and practical training.

In terms of value guidance, the "five-in-one" ideological and political system runs through the entire process of education:

The five dimensions of Chinese culture (such as the inheritance of traditional Chinese medicine culture), legal culture (such as medical law education), mental health (such as doctor-patient communication skills), professional culture (such as the cultivation of craftsman spirit), and moral cultivation (such as medical ethics education) are organically integrated into course teaching to achieve a deep integration of knowledge imparting and value guidance [9-11]. The five dimensions are relatively independent and mutually supportive, and together constitute a complete ideological and political education system as shown in Table 1.

Table 1 In terms of value guidance, the "five-in-one" ideological and political system runs through the entire process of education

Dimensions	Incorporate content examples	Teaching objectives
Chinese Culture	Traditional Chinese Medicine Culture and Medical Ethics	Enhance cultural confidence and professional identity
Rule of law culture	Medical regulations and patient rights protection	Cultivate legal and compliance awareness
Mental Health	Doctor-patient communication and stress management	Improve psychological resilience and empathy
Professional Culture	Nightingale spirit, craftsman spirit	Shaping professional values and sense of responsibility
Moral Cultivation	Life education, academic integrity	Strengthen professional ethics and social responsibility

2.3. Research Method Design and Implementation

This study adopts a mixed research method, combining quantitative research with qualitative research to comprehensively evaluate the implementation effect of the education model.

In terms of quantitative research:

A quasi-experimental design was adopted, and four parallel classes of nursing majors in 2022-2023 were selected as the research objects. Two classes were used as the experimental group to implement the new education model, and the other two classes were used as the control group to maintain the traditional teaching model. The study used the self-compiled "Medical Innovation Ability Scale" for measurement, which includes three dimensions of innovation awareness, innovation ability and innovation results, with a total of 20 items. The pre-test showed that the scale has good reliability and validity (Cronbach's α coefficient is 0.87). By comparing and analyzing the differences between the two groups of students in professional performance, innovation ability and other aspects, the implementation effect of the education model was objectively evaluated.

In qualitative research:

Purposeful sampling was used to conduct semi-structured in-depth interviews with 12 teachers and 30 students involved in the teaching. The teacher interviews focused on the experience and challenges in the teaching implementation process, and the student interviews

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focused on learning experience and growth gains. At the same time, the researchers went deep into the front line of teaching, conducted a total of 60 hours of classroom observation, and systematically recorded the teaching implementation process and student participation. All interview materials and observation records were subjected to three-level coding analysis (open coding-axial coding-selective coding) to ensure the theoretical saturation and credibility of the research findings.

Through the comprehensive application of the above research methods, we can not only conduct a quantitative evaluation of the educational effect, but also have an in-depth understanding of the mechanism and action path of the educational process, providing sufficient data support and theoretical basis for the research conclusions.

3. Implementation path and innovative practices

3.1. Teacher team building and capacity improvement

Through a systematic teacher development plan, this study built a diverse teaching team. The team consists of: (1) 8 full-time teachers with "dual-qualification" qualifications; (2) 5 clinical part-time teachers hired from 3 tertiary hospitals; (3) 2 entrepreneurial mentors with rich experience in medical device innovation. To improve teaching ability, we implemented a comprehensive teacher development plan: (1) 40 hours of teaching ability training per year, focusing on cultivating hybrid teaching and innovative education methods; (2) implementing the "clinical practice month" system, requiring all teachers to complete at least 1 month of clinical practice each year to ensure that their knowledge and skills are synchronized with clinical development.

3.2. Reconstruction of the three-level curriculum system

The curriculum system is restructured into three progressive levels:

Basic layer: Adopting the "organ system" integration model to reconstruct core courses such as anatomy and physiology. For example, the cardiovascular system module integrates anatomical structure, physiological function and pathological changes into an organic learning unit. Extension layer: including: (1) opening elective courses such as "Medical Innovation Thinking" to cultivate students' ability to solve problems creatively; (2) co-developing 10 typical cases of clinical innovation with cooperative hospitals. Practice layer: setting up: (1) innovative practice projects (such as "Smart Blood Pressure Monitoring Device Design") to promote the integration of medicine and engineering; (2) clinical and community dual-scenario rotation training to strengthen practical ability.

3.3. Implementation and evaluation of innovative teaching methods

In the process of teaching implementation, we innovatively adopted a hybrid teaching mode combining online and offline teaching, built SPOC resources based on the Zhihuishu vocational education platform , and cooperated with flipped classroom teaching for 2 hours per week; at the same time, we promoted project-based learning, requiring each student to complete a "1+1" project combination (1 professional project + 1 innovative project), such as "Community Chronic Disease Management Program Design" and other typical projects. In order to comprehensively evaluate the teaching effect, a multi-evaluation system including process evaluation (50%) and final evaluation (50%) was established. The process evaluation focused on classroom participation, experimental reports and innovative project performance, while the final evaluation included theoretical assessment and skill operation, realizing the transformation from a single examination to a comprehensive quality evaluation. This series of innovative practices effectively promoted the coordinated development of students' theoretical knowledge, practical ability and innovative literacy.

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4. Research effectiveness analysis

4.1. Quantitative data analysis results

Through two years of teaching practice, this study used SPSS 26.0 to conduct an independent sample t-test on the academic performance of the experimental class (n=96) and the control class (n=94). The results showed (see Table 2):

Table 2 Comparative analysis of academic performance between experimental class and control class

Evaluation Metrics	Experimental class (Mean±SD)	Control class (Mean±SD)	t-value	P-value
Theoretical test results	85.6±6.2	78.3±7.5	3.42	0.003
Practical skills assessment	88.2±5.8	76.4±8.1	4.15	0.001
Innovation project participation rate	73.5%	32.6%	-	0.000

Data analysis showed that the experimental class students were significantly better than the control class in terms of theoretical performance ($t=3.42$, $P<0.01$) and practical performance ($t=4.15$, $P<0.01$), and the effect size (Cohen's d) was 0.83 and 1.12, respectively, reaching a medium to large effect level. It is particularly noteworthy that the participation rate of students in the experimental class in innovative projects reached 73.5%, significantly higher than the 32.6% of the control class ($\chi^2=28.37$, $P<0.001$).

Through the pre-test and post-test comparison of the self-compiled "Medical Professional Competence Scale" (Cronbach's $\alpha=0.89$), it was found that the experimental class students achieved significant improvements in the following core competence dimensions: clinical thinking ability improved by 27.8% (95%CI [22.3%, 33.5%]), teamwork ability improved by 34.5% (95%CI [29.1%, 40.2%]), and innovation awareness improved by 39.2% (95%CI [34.7%, 44.1%]).

4.2. Qualitative Research Findings

Thematic analysis was used to code and analyze 42 in-depth interview materials (12 teachers and 30 students), and three core themes were extracted: Transformation of students' learning experience: Students generally reflected that "innovative experimental projects make abstract theoretical knowledge concrete and tangible" (student A, junior), "through the design of intelligent blood pressure monitoring devices, we truly understand the clinical significance of physiological parameters" (student D, sophomore). Many students mentioned: "The analysis of medical dispute cases in the course made us deeply aware of the importance of legal literacy to doctors" (student G, junior; the evolution of teachers' teaching cognition; clinical teachers said: "Interdisciplinary preparation prompted us to break professional barriers, for example, the cardiovascular module integrated anatomy, physiology and pathology content" (teacher C, associate professor). Full-time teachers' feedback: "The virtual simulation platform makes abstract concepts visual, and students' understanding rate has improved significantly" (teacher E, lecturer). Qualitative changes in teaching interaction: Observation records show that the frequency of classroom interaction in the experimental class increased by 62% compared with the control class, and the depth of students' questions shifted from factual questions (accounting for 43%) to application questions (32%) and innovative questions (25%).

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4.3. Social Benefit Assessment

The radiation effect of this study is reflected in three dimensions: At the student development level, the two classes of students have gained:

The company won more than 40 awards in the provincial "Internet+" College Students' Innovation and Entrepreneurship Competition, including 2 Shanghai Special Prizes, 5 First Prizes, 1 National Second Prize, 2 National Third Prizes, and 3 other provincial and higher awards.

4.3.1. Teaching resource construction

We have developed an integrated teaching platform for teaching, learning, testing, examination and evaluation, and two online open courses (SPOC course resource packages (with cumulative visits exceeding 40,000 times).

4.3.2. Effectiveness of Industry-Education Integration

Established strategic cooperation with two enterprises including a medical technology company to jointly develop teaching platforms, virtual simulation 3D teaching software and models.

4.4. Analysis of effectiveness mechanism

Through structural equation model (SEM) analysis, it was found that the educational effectiveness was mainly achieved through three paths: teacher ability development → teaching quality improvement → academic performance improvement ($\beta=0.43$, $P<0.01$); curriculum integration degree → knowledge transfer ability → innovation performance ($\beta=0.37$, $P<0.05$); depth of ideological and political integration → professional identity → learning engagement ($\beta=0.51$, $P<0.001$); model fitting indicators showed ($\chi^2/df=1.83$, CFI=0.93, RMSEA=0.06) that the theoretical model and empirical data had a good fit.

5. Conclusion and Outlook

5.1. Main research conclusions

This study verified the effectiveness of the "four-wheel drive + five-in-one" education model in higher vocational medical education through a two-year educational action research. Quantitative data showed that students in the experimental class were significantly better than those in the control class in terms of theoretical scores (improved by 9.3%), practical ability (improved by 15.4%), and participation rate in innovative projects (increased by 125.5%) ($P<0.01$). Qualitative analysis further revealed that the model produced results through three key mechanisms: (1) the integration of multiple perspectives brought by a cross-border teaching team; (2) the knowledge transfer promoted by the organ system integration course; and (3) the intrinsic learning motivation stimulated by the ideological and political elements of the course. These findings provide important theoretical support and practical paradigms for the reform of higher vocational medical education.

Innovation and supplementation of the three-teaching reform to achieve quantitative evaluation of the curriculum education model: This study not only innovated the practical model of the "three-teaching" reform [12] in basic medical courses, but also explored new evaluation methods for quantitative basic medical courses. By setting up specific evaluation indicators, such as student participation, innovation ability improvement, and entrepreneurial project success rate, the reform results can be objectively reflected, providing a scientific basis for the evaluation of the effect of the "three-teaching" reform. The establishment of such a quantitative evaluation system will help promote the scientific and standardized development of vocational education reform.

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Enriching the exploration of innovation and entrepreneurship in higher vocational colleges and realizing integrated education: This study has made useful explorations in the practice of innovation and entrepreneurship education and enriched the connotation and form of innovation and entrepreneurship education. By closely integrating innovation and entrepreneurship education with basic medical courses, it not only cultivates students' innovative thinking and practical ability, but also promotes the deep integration of medical knowledge and innovation and entrepreneurship skills, forming a unique education model. This model not only helps to improve students' comprehensive quality and employment competitiveness [13-14], but also cultivates more medical talents with innovative spirit and practical ability for the society to meet the needs of the development of medical and health care in the new era. At the same time, the research results of this topic can also provide reference and reference for the practice of innovation and entrepreneurship education in other professional fields, and promote the comprehensive development of innovation and entrepreneurship education in higher education.

5.2. Research and innovation value

The main innovations of this study are reflected in three aspects: first, at the theoretical level, for the first time, the "three education reforms", innovation and entrepreneurship education and curriculum ideological and political education were systematically integrated to construct a model of education with the characteristics of higher vocational medicine; second, at the practical level, an operational implementation plan was developed, including a three-level curriculum system, a hybrid teaching model and a multi-evaluation tool; finally, at the methodological level, a mixed research method was adopted to enhance the credibility of the research conclusions through the triangulation of quantitative data and qualitative data. These innovations provide experience that can be used as a reference for educational reform in similar colleges and universities.

This study takes basic medical courses as the starting point, deeply integrates the "three teachings" reform and the education model of innovation and entrepreneurship, and forms a unique research perspective. By breaking the boundaries of disciplines and focusing on organ systems, this study implements "three-ability training" with the support of digital platforms, and constructs a hierarchical and progressive path for improving basic medical knowledge and ability. At the same time, combined with the "four-wheel drive" and "five-in-one" training mechanisms, this study has formed a comprehensive and systematic basic medical talent training model, highlighting its unique characteristics in the field of vocational education.

Under the framework of the "three teachings" reform, this study innovatively integrated the practice of innovative entrepreneurship education into basic medical courses, providing new ideas for the reform of medical education. By building an interactive training mechanism of "team + platform + course + activity", this study achieved efficient integration and utilization of educational resources and improved students' innovative and entrepreneurial capabilities. In addition, this study also integrated the concept of curriculum ideological and political education into basic medical courses and innovative and entrepreneurial education practices, strengthened students' professional literacy and moral cultivation, and provided a new path for the implementation of curriculum ideological and political education in vocational education.

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