Exploration of Teaching Reform for Cultivating Innovation Ability of Pharmacy Undergraduates through the Synergistic Drive of Disciplinary Competitions and the College Student Innovation Program

Houkang CAO, Kefeng ZHANG, Bo LI, Jianzhao WU, Ya GAO, Hui CHEN*

Guilin Medical University, Guilin 541199, China

Abstract In response to the practical problems of insufficient cultivation of innovative thinking, weak practical application ability, and fragmented research training systems among current pharmacy undergraduates, this study constructs a theoretical model of synergistic education characterized by "competitiondriven innovation, innovationdriven learning, and deep integration of competition and innovation", using disciplinary competitions and the College Student Innovation and Entrepreneurship Training Program (College Student Innovation Program) as dual core carriers. Through the coordinated integration of disciplinary competition resources, optimization of the toplevel design of the College Student Innovation Program, establishment of interdisciplinary practical platforms, and construction of a wholeprocess diversified evaluation system, the core abilities of pharmacy undergraduates including scientific research thinking, practical operation, teamwork, and innovation achievement transformation are systematically strengthened. Based on the inherent laws of cultivating innovative pharmaceutical talents and the development needs of the pharmaceutical industry, this study explores the theoretical reconstruction of educational pathways, providing a referenceable and scalable theoretical framework and implementation paradigm for the cultivation of innovative pharmaceutical talents in the new era.

Key words Pharmacy undergraduate; Disciplinary competition; College Student Innovation Program; Innovation ability; Synergistic education

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Pharmacy is an applied discipline that highly integrates theory, practice, and innovation. Under the backdrop of the "Healthy China 2030" strategy and the high-quality development of the pharmaceutical industry, higher pharmaceutical education urgently needs to cultivate interdisciplinary high-level talents who possess solid professional foundation, systematic scientific research literacy, and outstanding innovative practical ability[1]. At present, undergraduate pharmaceutical education still faces many structural contradictions. The curricula are centered on theoretical instruction, while laboratory teaching is largely based on confirmatory content, resulting in passive knowledge acquisition by students and making it difficult to form a complete scientific research mindset. Research training is attached to course experiments and graduation projects, showing fragmented, phased, and discontinuous characteristics. Students lack initiative in participating in scientific research and innovation activities, leading to a lag in the cultivation of innovative thinking and complex problemsolving ability. Disciplinary competitions and innovation and entrepreneurship training programs have long operated independently with scattered resources, failing to form an educational synergy, and the conversion rate of innovative achievements remains low[2-3].

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Houkang CAO (1993 –), male, P. R. China, assistant research fellow, devoted to research about pharmacology of traditional Chinese medicine.

* Corresponding author. Hui CHEN, associate professor, devoted to research about pharmaceutical preparations.

The Innovation and Entrepreneurship Training Program for College Students (hereinafter referred to as the "College Student Innovation Program") serves as a core platform for early research enlightenment and innovation training for undergraduates, emphasizing the entire process of project design, experimental implementation, data analysis, and outcome generation[4]. Disciplinary competitions, oriented toward practical competition, focus on testing students' innovative solution design, practical operational skills, and comprehensive presentation ability[5]. The two are highly aligned in terms of educational objectives, competency orientation, and implementation pathways. Their synergistic integration can construct a closed-loop educational system of "theoretical learning-scientific research practice-competitive enhancement-innovation transformation". Based on the educational philosophy of the "Pharmacy Spark Plan" at the College of Pharmacy, Guilin Medical University, this paper theoretically explores the teaching reform pathway for deeply integrating disciplinary competitions and the College Student Innovation Program, providing theoretical support and design ideas for the systematic cultivation of innovation capabilities among pharmaceutical undergraduates.

Current Situation and Problems

Disconnection between training models and practical demands

Traditional teaching is centered on the classroom and textbooks, and the experimental content tends to be largely verified and standardized. Students often passively complete operational tasks, lacking immersive experience in real pharmaceutical research scenarios. This makes it difficult to establish a complete scientific research logic chain of "problem raising-solution design-experimental verification-outcome summary", resulting in a deviation between talent cultivation and the actual needs of the industry.

Fragmented research training and lack of continuity

College Student Innovation Program projects are often carried out as shortterm tasks, lacking progressive longterm overall planning. Disciplinary competitions mostly involve phased sprints, and are characterized by intensive preparation before the competition and stagnation of outcomes afterward. The two have long operated independently, failing to form an innovation training system with orderly articulation, gradual progression, and continuous improvement.

Insufficient faculty and platform support capacity

Full-time faculty members are burdened with heavy research and teaching responsibility, leaving limited time and energy for guiding undergraduate innovation. The development of interdisciplinary teaching teams lags behind, making it difficult to meet the guidance needs for multidisciplinary pharmaceutical research. The openness of experimental and innovation platforms is insufficient, restricting students' conditions for independently conducting exploratory research.

Single evaluation system and inadequate incentive mechanisms

The evaluation of innovative ability overly relies on quantitative indicators such as course grades and paper publications, while neglecting process-oriented performance and comprehensive competency development. Incentive measures for student participation in competitions and innovation programs are insufficient, and the recognition of faculty guidance workload and performance incentive mechanisms are unsound, affecting the motivation and sustainability of both students and teachers.

Theoretical Feasibility of Synergistic Education

Consistency of objectives

Both the College Student Innovation Program and disciplinary competitions aim to enhance students' innovative spirit, practical ability, and comprehensive competence, aligning closely with the talent cultivation requirements for the pharmaceutical profession in the new era.

Complementarity of pathways

The College Student Innovation Program focuses on long-term, systematic, and immersive basic research training, while disciplinary competitions emphasize practical competitive ability testing and demonstration. The two support and reinforce each other, forming a complete ability cultivation chain.

Resource sharing

Guidance faculty, experimental platforms, research projects, and industrial resources can be shared, enabling resource integration and efficient allocation, reducing the cost of innovation education, and improving training effectiveness.

Policy support

Higher education reform in innovation and entrepreneurship is deepening continously. Educational initiatives such as the "Pharmacy Spark Plan" provides theoretical support and an implementation basis for the integration of disciplinary competitions and the College Student Innovation Program at the institutional, management, and platform levels.

Reform Ideas and Implementation Pathways

With the core objective of enhancing the innovation ability of pharmacy undergraduates, a theoretical model of synergistic education characterized by "one core, two carriers, three integrations, and four guarantees" is constructed, featuring the systematic cultivation of innovation ability as the core, disciplinary competitions and the College Student Innovation Program as the two carriers, and the promotion of competition-innovation integration, teaching-research integration, and industryeducation integration, supported by organization, faculty, platform, and institution as the four guarantee systems. As a result, a full-cycle, progressive, and practice-oriented theoretical framework for cultivating innovative talents is formed.

Toplevel Design: Building an Integrated Competition and Innovation Training System

Tiered and categorized progressive training For lowergrade students, basic disciplinary competitions and innovation-enlightenment College Student Innovation Program projects serve as carriers to solidify foundational professional knowledge and stimulate research interest and innovation awareness. For middle-grade students, comprehensive competitions and innovation-training College Student Innovation Program projects are emphasized to strengthen research design, experimental operation, and teamwork ability. For higher-grade students, practiceoriented innovation and entrepreneurship competitions and entrepreneurial-practice College Student Innovation Program projects are prioritized, focusing on the transformation of achievements and industrial application to enhance comprehensive innovation ability.

Twoway transformation and closedloop linkage A mechanism is established for the College Student Innovation Program to feed back into disciplinary competitions, optimizing mature research content from the innovation program into competition works and enhancing the scientific quality and innovation of competition outcomes. Guided by cutting-edge topics and innovative ideas from disciplinary competitions, research directions for the College Student Innovation Program are refined, increasing the precision and research value of project topics and avoiding low-level repetitive research.

Implementation pathways: fourdimensional synergy promoting the implementation of teaching reform

Curriculum integration to solidify the theoretical foundation of innovation Innovative thinking, research methods, and competition norms are integrated into core course teaching, and modular content such as literature search, experimental design, data processing, academic writing, and presentation skills are added. Teaching methods such as CBL/TBL are adopted, using real research cases and authentic competition problems as teaching materials to guide students to think actively and design independently, thereby achieving the simultaneous advancement of knowledge learning and ability training.

Project-driven approach to strengthen practical research training Relying on the "Pharmacy Spark Plan", a mechanism linking the College Student Innovation Program with graduation projects is established, forming a continuous training pathway of "joining a research group in the second year, establishing a project in the third year, and tranforming outcomes in the fourth year", thereby bridging the training chain of "scientific research training-graduation project-industrial adaptation". An interdisciplinary supervisor team and a tiered guidance model are established, with standardized whole-process management of project initiation, midterm review, and final completion, and strengthened process guidance and quality control.

Competitiondriven innovation to enhance comprehensive innovation competence A fourlevel disciplinary competition system (college-university-province-nation) is established to build a pharmaceutical-featured competition brand. A mechanism for incubating outstanding projects through competitions is developed, deeply integrating competition training with project research. Competitions are used to test innovation outcomes, and research supports competition performance, thereby achieving competition-driven learning and competitiondriven innovation.

Industry-education integration aligning with industrial development needs Based on the actual needs of the pharmaceutical industry, practical scenarios are co-built with enterprises and research institutions, and industry mentors are invited to participate in guidance. Project and competition topics are designed around key industrial issues such as the development of ethnic medicines, optimization of formulation processes, and improvement of quality standards, thereby promoting the alignment of innovation training with industrial needs.

Guarantee system: ensuring the longterm and stable operation of the teaching reform

Organizational guarantee An innovation and entrepreneurship education co-ordination organization is established, responsible for top-level design, resource coordination, process management, and quality evaluation, ensuring the orderly advancement of competition and innovation integration.

Faculty guarantee Interdisciplinary innovation guidance teams and faculty training mechanisms are established, with clear recognition of guidance workload and performance incentive systems to stimulate teachers' enthusiasm for guidance.

Platform guarantee The experimental teaching center and research platforms are opened to provide equipment, consumables, and technical support for project research and competition preparation, thereby establishing a supporting platform for undergraduate innovation practice.

Institutional guarantee Supporting systems such as innovation credit recognition, outcome rewards, and preferential consideration in evaluations and awards are improved, forming a long-term incentive mechanism to stimulate students' initiative to participate.

Theoretical value and innovation points

Model innovation The traditional pattern of independently operating disciplinary competitions and the College Student Innovation Program is broken through, and a new synergistic education model of "competitioninnovation integration" is constructed. This solves the problems of fragmented and discontinuous innovation training at the toplevel design level and improves the theoretical framework for cultivating innovation ability among undergraduate pharmacy students.

Pathway innovation A tiered, categorized, progressive, and full-cycle training pathway is proposed, organically integrating course teaching, project research, competition practice, and industrial practice to form a closedloop educational system. It enriches the implementation pathways for innovation and entrepreneurship education in pharmacy.

Mechanism innovation A four-in-one guarantee mechanism integrating organization, faculty, platform, and institution is constructed, providing theoretical ideas for resource integration, faculty collaboration, and evaluation incentives. It offers a theoretical reference for similar institutions to carry out related teaching reforms.

Feature integration Based on regional pharmaceutical resources and the institution's educational positioning, the characteristics of ethnic medicines, industrial needs, and innovation training are integrated, reflecting the relevance and differentiation of talent cultivation in local medical colleges.

Discussion and Prospects

The synergistic education of disciplinary competitions and the College Student Innovation Program is an important theoretical pathway to address the traditional problems in pharmaceutical education of emphasizing theory over practice and knowledge over innovation[6-7]. This study has conducted theoretical explorations from the aspects of top-level design, implementation pathways, and guarantee mechanisms, reconstructed the innovation ability cultivation system, and promoted the transformation of pharmaceutical education from knowledge transmission to competency-based learning, thereby providing theoretical support for enhancing the innovative spirit and practical ability of undergraduate students.

Future research can further deepen theoretical studies. First, the deep integration of ethnic medicine characteristics with innovation training should be continuously promoted. The topic selection system should be improved based on regional resource advantages, and the institutional educational characteristics should be highlighted. Second, digital and information-based empowerment should be strengthened. An innovation training platform integrating online and offline models should be built, and the time and space for training should be expanded. Third, a wholeprocess diversified innovation ability evaluation system should be improved, and process-oriented evaluation and outcome-transformation orientation should be strengthened. Fourth, theoretical research on industry-education collaboration should be deepened. A higher level of alignment between talent cultivation and industrial needs should be promoted, and solid theoretical support should be provided for talent cultivation for the highquality development of the pharmaceutical industry.

Conclusion

Taking disciplinary competitions and the College Student Innovation Program as two driving forces to construct a new synergistic education model is an important theoretical direction for the reform of undergraduate pharmaceutical education in the new era. Through the deep integration of competition and innovation and the synergistic linkage of teaching, research, and industry, a systematic innovation ability cultivation system can be constructed to enhance students' comprehensive competencies. This approach provides theoretical ideas and implementation frameworks for cultivating innovative pharmaceutical talents who meet the needs of the highquality development of the pharmaceutical industry, thereby contributing to the Healthy China strategy and the highquality development of the pharmaceutical field.

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