Journal of Contemporary Educational Research, 2025, Volume 9, Issue 5
http://ojs.bbwpublisher.com/index.php/JCER
ISSN Online: 2208-8474
ISSN Print: 2208-8466

Research on the Teaching Practice of Integrated Science and Education in Pharmacy Comprehensive Experiment Based on Regional Characteristics

Jike Bai[1], Jie Sun[2,3]*, Meiyue Li[1], Le Li[4]*

[1]Dongguan Seventh People's Hospital, Dongguan 523000, Guangdong, China
[2]Rajamangala University of Technology Rattanakosin, Nakhonpathom 73170, Thailand
[3]Changsha Wangcheng District Kunyuan Social Work Service Center, Changsha 410299, Hunan, China
[4]School of Pharmacy, Shihezi University, Shihezi 832000, China

***Authors to whom correspondence should be addressed.**

Abstract: The integration of science and education represents the organic fusion of scientific research with educational instruction, constituting a critical trend in the advancement of modern higher education. This integration not only enhances teaching quality but also drives innovation in scientific research and fosters high-caliber talent development. The curriculum team has carefully selected experimental content from recent scientific research outcomes that aligns with students' core courses, features an appropriate level of difficulty, incorporates interdisciplinary and regional characteristics, and demonstrates innovativeness, practicality, and scientific rigor. This content is systematically incorporated into the talent cultivation process, enabling students to fully comprehend the principles of pharmaceutical research through hands-on experimentation. Furthermore, it strengthens students' experimental operational skills and cultivates their spirit of scientific inquiry, thereby achieving superior teaching outcomes.

Keywords: Regional characteristics; Integration of science and education; Pharmacy comprehensive experiment

Online publication: May 28, 2025

1. Introduction

The integration of science and education represents a mode that organically combines scientific research with educational instruction, playing a vital role in the teaching process for undergraduates. It introduces the latest scientific research achievements into the classroom, aligning theoretical teaching content with practical work. Teachers convert their own research topics into teaching cases, helping students visualize abstract theoretical knowledge and understand the latest developments in the discipline. This not only enriches the teaching content but also stimulates students' interest in learning [1]. The integration of science and education provides students with opportunities to participate in scientific research practices. By engaging in teachers' research projects or laboratory work, students can apply the theoretical knowledge learned in the classroom to practical problems, enhancing their experimental operational skills and scientific thinking. This practical learning contributes to cultivating students' innovative and problem-solving abilities, laying the foundation for their future academic research or career development. Additionally, the integration of science and education promotes interdisciplinary learning and the cultivation of comprehensive abilities. Scientific research projects often involve the integrated application of multidisciplinary knowledge, allowing students to broaden their horizons and enhance their interdisciplinary thinking abilities during the participation process. Meanwhile, components of scientific research activities, such as teamwork, literature retrieval, and data analysis, also help improve students' overall scientific literacy [2–5].

2. Background of setting up comprehensive experiments through the integration of science and education

In the traditional pharmaceutical education system, the experimental teaching of core courses such as medicinal chemistry, pharmacology, pharmaceutics, and pharmaceutical analysis has long been mutually independent. Although each discipline has set up verification experiments, the barriers between disciplines have made it difficult to achieve organic integration of the knowledge system. After completing their professional courses, students often struggle to systematically integrate key technical links such as drug synthesis, activity screening, formulation technology, and quality control when facing the needs of actual drug development. This "island of knowledge" phenomenon significantly affects the cultivation of students' scientific research thinking abilities, resulting in issues such as fragmented experimental design and unsystematic technical routes during their internship stage. Addressing this teaching challenge and constructing a comprehensive experimental system that integrates science and education has become an important direction for the reform of pharmaceutical education [6–8].

The curriculum team has attempted to break traditional disciplinary boundaries using the entire drug development process as a chain, adopting a modular design to organically connect drug discovery, pharmacodynamic evaluation, formulation development, and other links. Each module maintains its professional characteristics while forming a logical closed loop through the transmission of experimental data, enabling students to intuitively understand the synergistic relationships between disciplines [9,10]. The teacher team needs to establish an interdisciplinary lesson preparation mechanism and jointly optimize technical connection points through regular discussions and exchanges on experimental projects.

3. Design ideas for comprehensive experiments through the integration of science and education

The design of comprehensive experiments through the integration of science and education requires comprehensive consideration of the interdisciplinary nature, research conversion, and diverse goals for student ability cultivation. The design should cover the entire process of drug discovery, evaluation, formulation, and quality control. Following the principle of research feeding back into teaching, the teachers' research achievements are converted into teaching cases [11]. When constructing a comprehensive experimental system for pharmacy through the integration of science and education, selecting appropriate experimental projects is crucial. Firstly, the difficulty of the experiments needs to be moderate, fully considering the current knowledge and skill levels mastered by most students. The experimental design should stimulate students' interest in learning and exploration without being too difficult to discourage them. The experimental content should match students' knowledge reserves, allowing them to gradually delve deeper and consolidate and expand theoretical knowledge through practice. Secondly, experiments should be continuous, connecting the knowledge and skills of multiple disciplines.

Through continuous experimental design, students can gradually construct a complete pharmaceutical knowledge system in practice. Additionally, the experimental cycle should not be too long, and experimental results should be obtainable within a relatively short period. Pharmaceutical experiments often require a significant amount of time and effort, but if the experimental cycle is too long, students may lose interest and patience. Therefore, the design of experimental projects should focus on efficiency, preferably selecting experiments that can be completed and yield preliminary results within a relatively short period. This can provide timely feedback on the experimental effects, allowing students to see the results of their efforts within a short time, enhancing their sense of achievement and self-confidence in learning. At the same time, this aligns with the fast-paced requirements of modern higher education, cultivating students' practical abilities and innovative thinking within a limited time. Incorporating regional characteristics is also an important consideration for selecting experimental projects. Many regions in China are rich in unique medicinal material resources, which not only have distinct medicinal values but are also closely related to local culture and economic development. Therefore, experimental projects should be as closely combined with the research and development of regional medicinal materials as possible, enabling students to participate in the research and development of their hometown's medicinal materials. Through this approach, students can not only learn pharmaceutical professional knowledge and skills but also gain a deeper understanding of their hometown's medicinal material resources, enhancing their sense of identity and belonging to their hometown, and subsequently increasing their enthusiasm and sense of responsibility to serve their hometown. In summary, when selecting comprehensive experimental projects for pharmacy through the integration of science and education, multiple factors such as experimental difficulty, continuity, cycle, and regional characteristics need to be comprehensively considered.

4. Content construction of comprehensive experiments integrating science and education

The course group to which the authors belong selected Tianshan Viola as the experimental research object through a comprehensive evaluation. Tianshan Viola is a characteristic medicinal material in Xinjiang. It is distributed in Tianshan Mountain, Kunlun Mountain, and other places in Xinjiang. It is widely used among the people, mainly for colds, fevers, furuncles, carbuncles, lymphadenopathy, and other diseases. The teachers of the course group are committed to the development and utilization of this medicinal material. They have conducted a series of scientific research explorations around this drug and accumulated rich scientific research results. Through research, it was found that this medicinal material contains a variety of compound components, among which flavonoids and polysaccharides show significant antioxidant and antibacterial effects. Through network pharmacology research, combined with database data and Cytoscape software analysis, the team revealed that Tianshan Viola has a significant inhibitory effect on inflammatory response, bacterial infection, tumor cell growth, and melanin production, especially the targets of multiple components are closely related to anti-inflammatory efficacy, which provides a theoretical basis for subsequent experiments. On this basis, the teaching team further separated and purified the flavonoid active ingredients in Tianshan Viola and verified its efficacy through anti-inflammatory experiments. Finally, it was prepared into a convenient gel, and a quality evaluation standard based on high-performance liquid chromatography (HPLC) was established. Based on the above foundation, the course group took the research and development of Tianshan Viola, a characteristic medicinal material in Xinjiang, as the starting point, and designed the preparation and quality evaluation experiment of Tianshan Viola gel. The specific experimental design is as follows.

4.1. Medicinal chemistry: Investigation of medicinal material extraction and purification process

The experiment first cleans and crushes the Tianshan Viola, removes impurities, and sets it aside. In terms of extraction process optimization, the Box-Behnken central composite design was used in combination with the response surface method to comprehensively optimize the ultrasonic extraction conditions of total flavonoids from *Viola tianshanica* in order to improve the extraction rate of total flavonoids. The experiment used the total flavonoid content as an indicator, optimized the ultrasonic extraction conditions through single-factor experimental investigation and response surface analysis, and finally determined the optimal extraction process. In terms of the purification process, macroporous adsorption resin was used to separate and purify the extracted total flavonoids from *Viola tianshanica*. Macroporous resin has the advantages of high physical stability, good adsorption selectivity, simple regeneration, and low cost, and is suitable for industrial production [12]. The experiment investigated the adsorption and desorption properties of four macroporous resins—AB-8, D101, NKA-9, and S-8. Through static adsorption tests and dynamic tests, the adsorption amount and other indicators were calculated to screen out the best purification resin type to achieve efficient enrichment of total flavonoid components from *Viola tianshanica*.

4.2. Pharmacology: Anti-inflammatory experiment of medicinal extracts

In order to verify the anti-inflammatory effect of the total flavonoid extract of *Viola tianshanica*, an acute inflammation model was constructed using Kunming mice. There was a blank control group (normal saline), a positive drug control group (dexamethasone), a low-dose administration group, a medium-dose administration group, and a high-dose administration group. The experiment used the xylene-induced mouse ear swelling model, which is characterized by local vasodilation and increased capillary permeability. It is mainly used to evaluate the effect of drugs on the early stage of inflammation. By comparing the groups, statistical analysis was performed to evaluate the anti-inflammatory effect of *Viola tianshanica* extract.

4.3. Pharmacy: Preparation process of Viola tianshanica gel preparation

Viola tianshanica has significant therapeutic effects in the treatment of carbuncle swelling and pain. In order to better exert its medicinal value, the experiment prepared its alcohol extract into a topical gel. The gel has the advantages of slow and uniform drug release and convenient administration, and is suitable for the treatment of local skin diseases. Combined with the results of the previous preliminary experiment, the prescription and dosage of the gel matrix were determined. Through orthogonal experiments, xanthan gum was used as the main material to investigate the optimal ratio of hydrogel, and the formability and water loss rate were used as evaluation indicators for weighted scoring. According to the optimized conditions, the prepared Tianshan Viola gel should be yellow, clear, uniform, semi-solid, with moderate viscosity, non-irritating to the skin, fast film formation, and no abnormal odor.

4.4. Drug analysis: Quality standard investigation of Tianshan Viola gel preparation

Tianshan Viola contains a variety of active ingredients, among which quercetin and kaempferol are closely related to its efficacy and have a high content, and are selected as quality evaluation indicators. Quercetin is a coumarin component, and kaempferol is a flavonoid component. The experiment used high-performance liquid chromatography to determine the content of quercetin and kaempferol in the gel. At the same time, repeatability tests, precision tests, and sample recovery tests were carried out to verify the accuracy, precision, and specificity of the method. Content standards were formulated based on literature records and previous explorations. The test results were used to determine whether the preparation met the quality standards, and the preliminary quality evaluation of the Tianshan Viola gel was completed [13,14].

5. Arrangement of comprehensive experiments integrating science and education

In the concentrated practice phase of the pharmacy major, the course group designed a four-week comprehensive experimental project to comprehensively improve students' professional literacy and practical ability. The experimental project takes the preparation and quality evaluation of Tianshan Viola gel as the core content. Through scientific and reasonable experimental arrangements and teaching methods, students can fully exercise their abilities in literature review, experimental design, practical operation, data analysis, and report writing within a limited time. The entire comprehensive experimental project is divided into four stages, corresponding to the core contents of the four disciplines. The first week is the drug chemistry part, which mainly studies the extraction and purification process of Tianshan Viola; the second week enters the pharmacology stage to verify the anti-inflammatory effect of the extract; the third week conducts pharmacy experiments to prepare gel preparations and optimize the prescription; the fourth week focuses on drug analysis and conducts quality evaluation of the gel. Since the experiment was rich in content and had a large workload, students were divided into groups in advance, with each group consisting of 4–5 students, to ensure that each group member could fully play their role in the experiment. This group-based collaborative teaching model not only gave students a clearer understanding of the experimental content but also cultivated their teamwork spirit and independent learning ability. The cultivation of this collaborative spirit of solving problems in a team is of great significance to students' future career development.

6. Evaluation of the effect of comprehensive experiments integrating science and education

Teaching practice shows that this model significantly improves students' comprehensive scientific research literacy. Through questionnaire surveys, it was found that 90% of students believed that multidisciplinary cross-experiments helped to establish systematic research and development thinking, and 95% of participants said that they improved their literature research and program design capabilities. In terms of the quality of experimental reports, students' scores improved by 40%. What is more noteworthy is that students participating in the project showed stronger technical integration capabilities in their graduation project research, and the first-time pass rate of graduation papers increased by 15% compared with previous years. After two rounds of teaching practice, this experiment has significantly improved students' experimental operation level and scientific thinking, with significant results. Students' learning enthusiasm has increased, and their interest in experimental operations has become stronger.

The comprehensive experiment integrating science and education is suitable for students majoring in pharmacy, clinical pharmacy, and pharmaceutical engineering. The experiment involved basic knowledge such as literature review, data statistics, and animal modeling, and exercised experimental operation skills such as ultrasonic extraction, high-performance liquid chromatography, and column chromatography. It cultivated students' ability to analyze and solve problems. This experiment combined local medicinal plant resources with practical applications, improved students' learning enthusiasm, and played a good leading and exemplary role in helping students to enter internship positions and better carry out scientific research. It is an effective form of cultivating college students' practical and innovative abilities.

Funding

Research on the Undergraduate Education and Teaching Reform of BingTuan "Research on the Construction of Knowledge Graphs for the Core Pharmacy Courses under the Background of Digital Intelligence" (BTBKXM-2024-Y06)

Disclosure statement

The authors declare no conflict of interest.

References

[1] Zhou GL, Ma HQ, 2012, Integration of Science and Education: The Transformation and Innovation of Higher Education Concepts. China Higher Education Research, (8): 15–23.

[2] Zhang DL, 2020, Improving the Quality of Talent Cultivation through the Implementation of "Three Integrations." China Higher Education Research, (3): 1–3.

[3] Wu F, Wu C, Zhu Q, 2022, Promoting the Cultivation of Innovative Talents in Artificial Intelligence through the Integration of Science and Education and Industry-Education Collaboration. China University Teaching, (Z1): 15–19.

[4] Zhou CY, Liu Y, Zhang HT, et al., 2016, Research on Outcome-Based Education (OBE) Oriented Stepwise Practical Teaching. Laboratory Research and Exploration, 35(11): 206–208 + 220.

[5] Lu XZ, Wang J, 2024, Promoting the Cultivation of Top-Notch Innovative Talents through the Integration of Science and Education from the Perspective of New Quality Productivity Development. Jiangsu Higher Education, (8): 13–24.

[6] Li Q, Lu W, Wang WL, et al., 2000, Determination of Aesculetin Content in Processed Semen Euphorbiae. Chinese Traditional Patent Medicine, 22(2): 137–139.

[7] Liu XK, 2023, Exploration of Pathways for General Universities to Promote Vocational-General Integration, Industry-Education Integration, and Science-Education Synergy. Strategic Research on Scientific and Technological Innovation Development, 7(2): 23–30.

[8] Sun FF, Sun XX, Gao XY, et al., 2024, Integration of Industry, Science, and Education to Empower New Quality Productivity: Coupling Mechanisms, Practical Challenges, and Implementation Directions. China Vocational and Technical Education, (25): 11–17.

[9] Wang JM, Bai YX, 2018, Cultivating First-Class Talents: Transforming Talent Cultivation Models through Science-Education Integration. University Education Management, 12(3): 109–115.

[10] Zhou JM, Zhang HZ, Chen X, et al., 2017, Exploration of the Construction of Medical Education Talent

Cultivation System: A Case Study of Wenzhou Medical University. Educational Research, 38(11): 147–151.

[11] Qi Y, Wang CC, 2017, Practice and Exploration of Top-Notch Innovative Talent Cultivation Models under the Perspective of Science-Education Integration. Beijing Education (Higher Education), (Z1): 133–136.

[12] Tian W, Zhen YQ, Wang XG, et al., 2018, Applicability Study of a Single-Standard Quantitative Method for Multi-Component Determination in Lonicera japonica. Chinese Journal of Information on Traditional Chinese Medicine, 25(11): 77–82.

[13] Wang F, Wang YH, Wang XP, et al., 2018, Determination of Fraxin and Aesculetin in Branch Bark and Dried Bark of Cortex Fraxini by HPLC. Central South Pharmacy, 16(9): 1299–1302.

[14] Li XY, Zhang D, Tang LZ, et al., 2016, Simultaneous Determination of Four Components in Cortex Fraxini by HPLC. Shaanxi Journal of Traditional Chinese Medicine, 37(9): 1238–1240.