"Case + Project" Integrated Professional and Innovation-entrepreneurship Education Teaching Model for Medical Chemistry Based on the Concept of Three-dimensional Innovation Resilience

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Abstract Given the insufficient integration between professional education and innovation and entrepreneurship education within the medical chemistry course, as well as the inadequate development of students' innovative consciousness and practical skills, this paper clearly defines the training requirements across three dimensions: innovation resilience awareness, ability, and behavior. The course objectives, teaching content, and assessment methods are structured in accordance with the OBE concept. In teaching, the primary approach employed is the "case + project" method, which integrates medical-related scenarios into the classroom setting. This approach guides students to analyze problems in relation to the course content, and problems with potential for further exploration are further converted into project tasks. Through the data review, concept design, practical verification, and iterative modification, students' abilities to apply knowledge and solve problems are progressively enhanced. The course integrates extracurricular activities, including innovation and entrepreneurship training, subject competitions, and scientific research practices, with classroom instruction, and employs a combination of formative and summative assessments to emphasize students' knowledge acquisition, problem analysis, and task completion. This teaching approach seeks to integrate innovation training into the medical chemistry curriculum, offering a framework for the enhanced integration of professional education with innovation and entrepreneurship education.

Key words Medical chemistry, Integrated professional and innovation-entrepreneurship education, Innovation resilience, Case teaching, Project teaching

1 Introduction

Medical chemistry is a fundamental course for clinical medicine, pharmacy, nursing, and related disciplines in medical colleges and universities, and serves as a critical link between the foundational theories of chemistry and their medical applications. However, within the current framework of integrated professional and innovation-entrepreneurship education, several challenges persist, including insufficient integration between professional education and innovation-entrepreneurship education, inadequate incorporation of medical cases and real-world problems, weak alignment between project tasks and course objectives, and a lack of systematic design aimed at fostering students' innovation resilience. Innovation resilience involves not only innovation awareness but also innovation ability and innovation behavior, which are progressively developed through knowledge acquisition, problem exploration, and practical tasks. Based on this, this paper introduces the concept of three-dimensional innovation resilience, adopts OBE as its guiding framework, and employs a "case + project" teaching approach that integrates medical scenarios, problem analysis, project practice, and extracurricular activities. It further explores the implementation pathway for integrating professional and innovation-entrepreneurship education in medical chemistry, aiming to provide valuable insights for the reform of foundational medical courses and the cultivation of innovative talent.

2 Problems in the integrated professional and innovation-entrepreneurship education in medical chemistry

2.1 At the student level, there is a deficiency in effective learning strategies and a lack of motivation to engage in innovative activities Medical chemistry is typically offered during the first year of university. Upon entering university, students often persist with a learning approach that primarily emphasizes knowledge acquisition and exam completion, demonstrating limited motivation to engage in innovative problems and open-ended tasks within their professional studies.

2.2 At the course level, the integration between innovation and entrepreneurship education and professional courses remains insufficiently developed Innovation and entrepreneurship education is predominantly delivered through standalone courses, lectures, competitions, or major innovation and entrepreneurship projects, and it is not closely integrated with medical chemistry curricula[1]. Students often perceive innovation and entrepreneurship as supplementary material unrelated to their core professional

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studies.

2.3 At the level of teaching implementation, it is necessary to enhance both the assessment methods and the instructional guidance skills of teachers From the perspective of teaching implementation, current experiments and course assessments predominantly emphasize prescribed procedures, standardized outcomes, and knowledge acquisition[2], while insufficiently addressing students' abilities in problem identification, plan development, process adjustment, and continuous inquiry. In the context of integrated professional and innovation-entrepreneurship education, teachers are required not only to deliver knowledge effectively, but also to transform practical medical challenges into cases and projects appropriate for lower-grade students, providing essential guidance for innovation. Therefore, the teaching of integrated professional and innovation-entrepreneurship education in medical chemistry necessitates a comprehensive design encompassing course objectives, teaching content, practical tasks, and assessment methods.

In response to the above issues, this paper clarifies student cultivation requirements grounded in three-dimensional innovation resilience. It aligns course objectives, teaching content, and assessment methods with the OBE concept and employs a "case + project" approach as the primary teaching method. This strategy aims to develop a teaching model for integrated professional and innovation-entrepreneurship education in medical chemistry. The comprehensive design is presented in Table 1.

Table 1 Comprehensive design of integrated professional and innovation-entrepreneurship education in medical chemistry

Content	Main function	Manifestation in the medical chemistry course
Integrated professional and innovation-entrepreneurship education	Clarifying the direction of curriculum reform	Integrating professional knowledge acquisition with innovative practice to embed innovative educational approaches within the teaching of medical chemistry courses
Three-dimensional innovation resilience	Building a framework for student cultivation	Establishing appropriate training requirements focused on enhancing awareness, capabilities, and behaviors related to innovation resilience
"Case + project" teaching approach	Providing specific teaching paths	Introducing medical issues through case studies, and conducting analysis, design, and practical application through projects
OBE concept	Providing a basis for teaching design and assessment	Organizing teaching content, tasks, and assessment methods in alignment with the anticipated learning outcomes

3 Concept of three-dimensional innovation resilience and the teaching of integrated professional and innovation-entrepreneurship education in medical chemistry

The innovation resilience of college students comprises three dimensions: awareness, ability, and behavior[3]. These dimensions correspond to innovative attitudes, coping and adjustment capabilities, and sustained performance of actions, respectively. Considering the specific characteristics of the medical chemistry course, these dimensions can be further transformed into targeted training requirements, as presented in Table 2.

Table 2 Cultivation content of three-dimensional innovation resilience in medical chemistry courses

Dimension	Cultivation focus	Specific manifestations in the study of medical chemistry
Awareness	Cultivating attentiveness to emerging knowledge, medical issues, and innovative activities, while fostering a positive attitude toward challenges and uncertain outcomes	Demonstrating a willingness to identify issues arising from medical-related phenomena, maintaining an interest in investigating unfamiliar problems, and exhibiting the capacity to accept uncertainties that may emerge during problem analysis
Ability	Enhancing the capacity to effectively mobilize knowledge, skills, and resources to address problems and adapting to changing circumstances	Demonstrating the ability to integrate pertinent knowledge, consult relevant materials, compare various factors, and promptly revise analytical reasoning when initial judgments are challenged
Behavior	Engaging in practical actions to continuously explore, experiment with, and address challenges	When the data are inconsistent, the results deviate, or the plan is obstructed, one can still proceed to analyze the causes, explore alternative approaches, and advance the task

3.1 Cultivation of innovation resilience awareness When freshmen are initially introduced to medical chemistry, their learning typically centers on concepts, formulas, and fundamental operations, often neglecting the integration of theoretical knowledge with clinical practice. Incorporating scenarios such as clinical medication and medical testing into teaching can effectively demonstrate the practical relevance of course content, thereby fostering students' interest in emerging issues and unfamiliar phenomena. At this stage, it is more crucial to cultivate students' willingness to engage with new knowledge, confront uncertain problems, and accept potential errors and failures during the analytical process, rather than expecting them to produce fully developed innovative solutions from the outset.

3.2 Enhancement of innovation resilience ability Practical problems in medical chemistry are typically influenced by multiple factors. Students must not rely solely on a single knowledge point but rather analyze these problems by integrating their existing knowledge, experimental skills, and relevant materials. As new information becomes available, initial judgments may require revision. This process necessitates that students connect diverse knowledge

domains, compare alternative explanations, and adapt their reasoning promptly in response to changing premises. Compared to the direct application of conclusions, such training more effectively fosters students' abilities to manage change and address practical problems.

3.3 Formation of innovation resilience behavior In the study of medical chemistry, students should be provided with ongoing opportunities to engage in experimentation and project tasks. When confronted with inconsistent data, unexpected experimental outcomes, or challenges in adhering to the original plan, students must critically reassess the foundation, compare alternative treatment methods, and adjust subsequent plans based on the results obtained. Through this iterative practical process, students can progressively convert their initial problem awareness and analytical skills into sustained actions, thereby developing stable innovative practices through repeated trials and refinements.

4 Teaching design of integrated professional and innovation-entrepreneurship education in medical chemistry under the OBE concept

The OBE concept emphasizes structuring course content, teaching activities, and assessment methods around the anticipated learning outcomes, ensuring that each component of instruction aligns with the competencies students are expected to achieve[4]. Building upon the training requirements outlined previously, this course transforms these requirements into implementable and observable learning outcomes, which subsequently guide the organization of teaching content, learning tasks, and assessment criteria. Specifically, the process follows a logical sequence: defining learning outcomes, implementing a reverse design approach to the development of teaching content, and establishing corresponding assessments. This design framework is illustrated in Fig. 1.

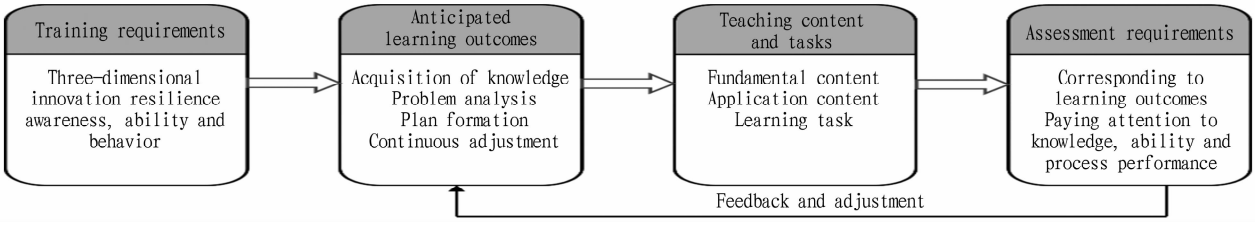


Fig. 1 Teaching design concept of integrated professional and innovation-entrepreneurship education in medical chemistry under the OBE concept

4.1 Transforming training requirements into anticipated learning outcomes The course must initially transform broad training objectives into specific, demonstrable outcomes that students can exhibit throughout the learning process[5]. Beyond acquiring fundamental knowledge and methods in medical chemistry, students should be capable of applying their acquired knowledge to analyze particular problems, make preliminary judgments, develop initial solutions, and revise their original understanding in light of new data or findings. These clearly defined outcomes facilitate implementation in teaching activities and assessments more effectively than generalized goals such as "enhancing innovation capabilities", while also providing a foundation for subsequent course content and task arrangements.

4.2 Implementing a reverse design approach to the development of teaching content and tasks After defining the learning outcomes, the course content and associated learning tasks are systematically organized. The fundamental knowledge of medicinal chemistry constitutes the core of the course teaching. On this basis, application-oriented content relevant to medical practice is incorporated, and learning tasks are designed to align with students' existing knowledge base. The complexity of these tasks progressively advances from basic comprehension and simple application to problem analysis and solution development, thereby facilitating the gradual enhancement of students' ability to apply knowledge throughout the course. The primary objective at this stage is not to introduce additional teaching material but to establish a clearer alignment between the original course content and the anticipated learning outcomes[6].

4.3 Establishing assessment requirements corresponding to learning outcomes The assessment content should align with the previously established learning outcomes[7]. Beyond assessing fundamental knowledge and basic methods, it is essential to consider students' abilities in problem analysis, knowledge application, and task progression. The assessment results serve not only to understand learning achievement but also to inform adjustments to subsequent teaching content and task arrangements.

5 Implementation of the "case + project" integrated professional and innovation-entrepreneurship education in medical chemistry

Case teaching and project teaching can be concurrently developed around a common issue. Case teaching primarily facilitates students' immersion in specific contexts, enabling them to comprehend problems and relate to pertinent knowledge. Project teaching converts problems requiring further investigation into practical tasks, thereby allowing students to apply acquired knowledge in the design, implementation, and refinement of plans[8]. The integration of these two approaches permits the continuation of problem analysis from the classroom to subsequent practical application. This implementation process progresses through three stages: case comprehension, project transformation, and project advancement.

5.1 Understanding medical-related issues through cases The selection of cases should closely integrate knowledge of medicinal chemistry with clinical practice, allowing students to identify chemical problems requiring analysis within specific contexts. In teaching, rather than directly presenting conclusions, questions are posed based on observed phenomena to encourage students to connect their prior knowledge and engage in judgment and discussion regarding potential influencing factors. Case teaching,

through discussion, analysis, and communication, facilitates students' understanding of medical-related issues in relation to course content and establishes a problem foundation for subsequent project tasks[9].

5.2 Transforming case problems into project tasks Based on case analysis, problems with potential for further exploration can be identified and transformed into project tasks. Students engage in consulting relevant materials related to specific problems, compare various explanations, and develop preliminary plans, which are subsequently validated through experiments or other practical methods. The project content should remain closely aligned with the course knowledge framework and should not be excessively broad. Rather, it should enable students to complete relatively comprehensive tasks utilizing their existing knowledge[10]. This approach ensures that the issues presented in the case extend beyond classroom discussion to encompass actual analysis and practical application.

5.3 Improving the plan during project advancement During the implementation of the project, students continuously revised their initial judgments based on existing data and actual outcomes. When results deviated from expectations, conditions were set inappropriately, or the plan became difficult to execute, students were encouraged to re-examine the underlying causes, compare alternative approaches, and adjust the original plan accordingly. In this process, teachers primarily provided essential guidance at critical junctures rather than offering complete solutions directly. Related research on project learning similarly emphasizes that after students develop their plans, they should refine and optimize them based on feedback from teachers or supervisors prior to further implementation[11].

6 Implementation effect and reflection of teaching reform

6.1 Course assessment and evaluation In the implementation of the course, the assessment plan is arranged in accordance with the learning outcomes established during the initial phase, employing a combination of formative and summative assessments. The overall course grade comprises two components: regular performance and the final examination score, weighted at a ratio of 4 ∶ 6. The final examination, which constitutes 60% of the total grade, primarily assesses students' mastery of fundamental knowledge and core methods. Regular performance accounts for 40% of the grade and is further divided as follows: research and competitions (5%), laboratory performance (10%), assignments and chapter tests (10%), classroom activities (10%), and course platform tasks (5%). Classroom activities encompass in-class exercises, discussions, and presentations. Research and competitions include the initiation of major innovation and entrepreneurship projects, research activities, and related contests. Beyond examination results, case analyses, project activities, and stage reports also serve as critical indicators for evaluating students' application of knowledge, problem-solving abilities, and task completion. This comprehensive approach ensures that the evaluation criteria established at the outset are effectively implemented throughout the course assessment process.

6.2 Implementation effect of teaching reform Based on classroom discussions, case analyses, project presentations, and the completion of stage tasks, there have been observable changes in students' engagement with course learning. When confronted with specific medical problems, students are required to consult relevant materials grounded in course content, make informed judgments, and explain the basis for their judgments. Throughout discussions and project progression, the comparison of differing interpretations and the revisions prompted by new information and results have increasingly become integral to the learning process. Some students continue to supplement materials or pose new questions after fulfilling the assigned tasks. It is important to note that these changes are mainly judged based on classroom observations and project process materials. At present, the absence of systematic quantitative data limits these findings to a preliminary reflection on the effectiveness of the teaching reform implementation.

6.3 Problems and improvements in teaching reform The effectiveness of teaching reform is influenced by various factors, including class hours, students' fundamental knowledge, teachers' guidance time, and practical conditions. Medical chemistry is primarily designed for lower-grade students, who exhibit variability in their fundamental knowledge, self-directed learning abilities, and innovative practical experience. An excessive number of open-ended or overly challenging tasks may increase the students' learning burden. As the number of projects grows, teachers are required to invest more time in data review, plan discussions, and process guidance. Group collaboration may encounter issues such as uneven participation among members. Importantly, the integrated professional and innovation-entrepreneurship education should not compromise the teaching of fundamental knowledge. Cases and projects must remain aligned with the course content and the students' existing fundamental knowledge[12]. Future teaching efforts should focus on selecting cases and projects appropriate for the medical chemistry course, regulating the quantity and difficulty of tasks, clearly defining stage-specific tasks and member responsibilities, and adapting guidance methods and evaluation criteria based on students' performance.

7 Conclusions

The integrated professional and innovation-entrepreneurship education in medical chemistry should not be achieved merely by adding innovative and entrepreneurial content; rather, it requires the genuine incorporation of innovation-oriented training within the learning processes of professional courses. This study, considering the learning characteristics of lower-grade medical students, has accordingly adjusted course objectives, teaching tasks, case studies, project implementation, and assessment methods. Such adjustments enable students not only to acquire fundamental knowledge but also to engage with medical-related issues, participate in analysis and practical activities, and continuously refine their understanding throughout task progression. The principal contribution of this research lies in transforming the concept of three-dimensional innovation resilience into specific training requirements for medical chemistry courses and in developing a "case + project" integrated teaching approach grounded in the OBE concept. None-

theless, the current reform exhibits certain limitations: teaching resources, task complexity, and assessment methods require further enhancement. In particular, it is essential to more carefully select cases and projects appropriate for lower-grade students, regulate the difficulty and quantity of open-ended tasks, and accumulate more process materials that reflect students' learning development. The applicability of this model warrants further validation through ongoing teaching practice, with continuous adjustments and improvements aligned with course implementation.

References

[1] GAO L, GUO LS, ZHANG F, *et al.* Design and reform of the "medical chemistry" specialized-innovation integration course for cultivating innovative applied medical talents[J]. Technology Wind, 2026(2): 89 – 91. (in Chinese).

[2] WANG JQ, CHEN HP, YUE DF. Reform and practical paths for the construction of Traditional Chinese Medicine Chemistry course from the perspective of specialty-innovation integration[J]. Science and Education Wenhui, 2026(8): 91 – 94. (in Chinese).

[3] CHENG JJ, GUO J, FENG QY, *et al.* Exploration of the specialized and integrated teaching mode of "Case + Project" under the concept of three-dimensional innovation resilience: Taking the national first-class offline undergraduate course "Financial Marketing" as an Example[J]. Journal of Beijing College of Finance and Commerce, 2025, 41(1): 77 – 82. (in Chinese).

[4] QI YW, MAI JY, ZHANG YH, *et al.* Construction of medical laboratory teaching model oriented to OBE and research enlightenment[J]. Basic Medical Education, 2026, 28(7): 636 – 641. (in Chinese).

[5] CHANG RM, LI Y, ZHANG GB. Research on scientific research back feeding teaching guided by OBE for the graduation design of pharmacy undergraduates[J]. Basic Medical Education, 2026, 28(8): 788 – 794. (in Chinese).

[6] LI YN, XU J, PU H, *et al.* Exploration on OBE-based teaching reform of the comprehensive experiment of Schistosoma[J]. Basic Medical Education, 2026, 28(1): 28 – 32. (in Chinese).

[7] LIU P, HAN XH, LI WL. On the connotation and practice of the OBE concept[J]. Theory Research and Practice of Innovation and Entrepreneurship, 2021, 4(10): 132 – 134. (in Chinese).

[8] TAO SH. Study on teaching model combining case and project[J]. Computer Engineering & Science, 2014, 36(12): 210 – 212. (in Chinese).

[9] XIN XQ. Inquiry teaching design and practice of alcohols and phenols in medical chemistry[J]. Chinese Journal of Chemical Education (Chinese and English), 2025, 46(8): 66 – 71. (in Chinese).

[10] XU S. Connotation, education pursuit and teaching characteristics of project teaching method[J]. Vocational and Technical Education, 2008, 29(28): 5 – 7. (in Chinese).

[11] SONG ZX, YU QD. Research on project-based teaching model based on flipped classroom[J]. Journal of Distance Education, 2014, 32(1): 96 – 104. (in Chinese).

[12] ZHANG J, ZHU L. Exploration on the teaching reform of "Integration of Specialization and Innovation" in organic chemistry course under the background of high quality development[J]. Theory Research and Practice of Innovation and Entrepreneurship, 2025, 8(13): 16 – 19. (in Chinese).

(From page 100)

dividualized nursing interventions, thereby contributing to improved patient safety and more efficient allocation of nursing resources.

Beyond their predictive capabilities, AI-EWS has the potential to facilitate a transition from reactive nursing to predictive and precision-based nursing care. However, challenges related to data quality, model interpretability, workflow integration, and ethical considerations continue to limit their widespread implementation. Future efforts should focus on strengthening the integration of AI-EWS into nursing practice, enhancing nurses' competencies in AI-assisted decision-making, and generating high-quality clinical evidence through multicenter studies. With ongoing technological advancements and appropriate clinical adoption, AI-EWS is expected to become a valuable tool for supporting intelligent, patient-centered critical care nursing.

References

[1] NEMATI S, HOLDER A, RAZMI F, *et al.* An interpretable machine learning model for accurate prediction of sepsis in the ICU[J]. Critical Care Medicine, 2018, 46(4): 547 – 553.

[2] JOHNSON AEW, POLLARD TJ, SHEN L, *et al.* MIMIC-III, a freely accessible critical care database[J]. Scientific Data, 2016, 3: 160035.

[3] THORSEN-MEYER HC, NIELSEN AB, NIELSEN AP, *et al.* Dynamic and explainable machine learning prediction of mortality in patients in the ICU[J]. Nature Communications, 2020, 11: 3853.

[4] RAJKOMAR A, OREN E, CHEN K, *et al.* Scalable and accurate deep learning with electronic health records[J]. The Lancet Digital Health, 2018, 1(1): e24 – e34.

[5] HENRY KE, HAGER DN, PRONOVOST PJ, *et al.* A targeted real-time early warning score (TREWScore) for septic shock[J]. Science Translational Medicine, 2015, 7(299): 299ra122.

[6] DESAUTELS T, CALVERT J, HOFFMAN J, *et al.* Prediction of sepsis in the ICU using machine learning[J]. Critical Care Medicine, 2016, 44(10): 1906 – 1915.

[7] SENDAK MP, GAO M, NICHOLS M, *et al.* Machine learning in health care: A critical appraisal[J]. BMJ, 2020, 368: m689.

[8] TOMAŠEV N, GLOROT X, RAE JW, *et al.* A clinically applicable approach to continuous prediction of future acute kidney injury[J]. Nature, 2019, 572: 116 – 119.

[9] KOYNER JL, CAREY KA, EDELSON DP, *et al.* The development of a machine learning inpatient acute kidney injury prediction model[J]. Critical Care Medicine, 2018, 46(7): 1070 – 1077.

[10] GAMEIRO J, FONSECA JA, NEVES M. Acute kidney injury prediction models: A systematic review[J]. Nephrology Dialysis Transplantation, 2020, 35(7): 1161 – 1171.

[11] GOH KH, WANG L, YEOW AYK, *et al.* Artificial intelligence in sepsis early prediction and diagnosis[J]. Journal of Critical Care, 2018, 48: 156 – 161.

[12] KOMOROWSKI M, CELI LA, BADAWI O, *et al.* The artificial intelligence clinician learns optimal treatment strategies[J]. Nature Medicine, 2018, 24: 1716 – 1720.

[13] HATIB F, JIAN Z, BUDDI S, *et al.* Machine-learning algorithm to predict hypotension[J]. Anesthesiology, 2018, 129(4): 663 – 674.

[14] DREW BJ, HARRIS P, ZÈGRE-HEMSEY JK, *et al.* Insights into alarm fatigue[J]. Journal of the American College of Cardiology, 2014, 63(18): 1986 – 1995.

[15] WIENS J, SARIA S, SENDAK M, *et al.* Do no harm: A roadmap for responsible machine learning[J]. Nature Medicine, 2019, 25: 1337 – 1340.

[16] TOPOL EJ. High-performance medicine: The convergence of human and artificial intelligence[J]. Nature Medicine, 2019, 25: 44 – 56.