Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.16, No.3, 2025

Exploration of Curriculum Reform for "Principles of Chemical Engineering Experiments" in Applied Chemistry under the Background of Emerging Engineering

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Abstract

This paper analyzes the necessity of further strengthening the position of "Principles of Chemical Engineering Experiments" as a foundational core course in applied chemistry majors at local undergraduate universities. Based on the characteristics of the course, the pedagogical requirements of applied chemistry programs, and the core competency standards for professionals under the emerging engineering framework, reform strategies and recommendations are proposed to construct an organically integrated knowledge system for principles of chemical engineering experiments. These suggestions align with the educational reform practices of Yancheng Teachers University.

Keywords: Applied Chemistry major, Strengthening, Emerging Engineering

DOI: 10.7176/JEP/16-3-07
Publication date: March 30th 2025

1. Introduction

Principles of Chemical Engineering Experiments is a fundamental technical course in four-year undergraduate applied chemistry programs. It employs mathematics, physics, chemistry, and engineering methodologies to address unit operation challenges encountered in chemical production processes, aiming to achieve economical, efficient, and scalable manufacturing of chemical products. Rooted in chemical technological research, this discipline bridges scientific discoveries and industrial applications through engineering practices.

With the rapid development of industries such as petrochemicals, fine chemicals, and biochemicals, professionals proficient in both upstream theoretical principles and downstream practical skills of applied chemistry are in high demand. As an engineering-oriented discipline, applied chemistry must adapt to the evolving needs of the era and market, cultivating talent suited to the emerging engineering paradigm. Therefore, guided by the disciplinary characteristics of applied chemistry and the educational reform ethos of Yancheng Teachers University, this study explores pedagogical innovations for Principles of Chemical Engineering Experiments. It emphasizes integrating classroom instruction with hands-on practice, shifting from teacher-centered to student-led learning models, enhancing students' innovation and practical capabilities, and embedding ideological-political education into the curriculum to lay a foundation for cultivating high-quality applied professionals[1, 2].

2. Analysis of Key Issues in Teaching "Principles of Chemical Engineering Experiments"

The course, grounded in the theory of "three transfers and one reaction" (heat transfer, momentum transfer, mass transfer, and chemical reaction), serves as a bridge connecting theoretical knowledge to engineering applications. However, students in applied chemistry programs at teacher-training universities often lack prior exposure to engineering concepts and problem-solving skills due to curriculum structures dominated by theoretical coursework and minimal engagement with industrial contexts[3]. This results in learning difficulties, disengagement, and a fear of complexity. The following issues were identified through classroom and practical teaching observations:

2.1 Overemphasis on Theoretical Fundamentals with Insufficient Engineering Content

Existing teaching materials focus on schematic explanations of unit operations but provide limited coverage of practical engineering knowledge, such as equipment, instrumentation, and process design. Students' inadequate foundational engineering literacy leads to abstract comprehension and disconnection from real-world applications. Additionally, topics like environmental protection and cost analysis, integral to chemical engineering, are seldom addressed in prior theoretical courses, exacerbating learning challenges.

2.2 Monotonous Teaching Methods and Tools

Traditional pedagogy prioritizes rote memorization of principles and formulas, with minimal exposure to physical devices or operational workflows. Despite mastering theoretical frameworks, students struggle to solve practical problems. Passive learning dominated by teacher-led lectures further stifles initiative and critical thinking.

2.3 Insufficient Integration of Ideological-Political Education

Current teaching practices lack systematic incorporation of ideological-political elements. Educators must not only impart knowledge but also cultivate students' professional ethics, patriotism, and social responsibility. Linking scientific laws (e.g., Bernoulli's equation, Henry's law, Raoult's law, Fourier's law) to historical narratives of scientists can inspire national pride and mission[6]. Case studies on safety, environmental compliance, and legal awareness in chemical production should also be integrated to achieve holistic education.

2.4 Students' Deficient Practical Competence

The course's strong practical orientation requires instructors to possess both theoretical expertise and industrial experience. However, most faculty members lack hands-on production knowledge, having transitioned directly from academic research to teaching. Consequently, students exhibit limited operational proficiency and fail to connect theoretical knowledge to real-world scenarios.

3. Key Directions for Curriculum Reform

3.1 Collaborative University-Enterprise Curriculum Development

To address students' "strong theoretical but weak practical" profile, a collaborative teaching framework integrating academic knowledge with industrial practices is essential. Establishing a "theory-practice-reinforced theory" cycle through structured internships and industry partnerships will foster interdisciplinary innovation and align education with societal needs[4].

3.2 Diversified Pedagogical Approaches and Expanded Content

Adopt student-centered methodologies such as flipped classrooms, interactive discussions, and case-based learning to enhance engagement and autonomy. Train students in data collection, analytical reasoning, and communication skills. Strengthen the course's role as a bridge between foundational and specialized courses by embedding advanced professional knowledge into experimental modules.

3.3 Synergy Between Ideological-Political Education and Technical Training

Incorporate ideological-political elements by highlighting scientists' contributions and ethical dilemmas in chemical engineering. Use case studies to emphasize safety protocols, environmental stewardship, and legal responsibilities, fostering socially conscious professionals[6].

3.4 Faculty Capacity Building

Optimize faculty structure by recruiting industry experts and encouraging existing instructors to undertake industrial internships. Strengthen practical teaching platforms, such as chemical engineering training centers, to enhance both teacher and student competencies in engineering applications.

6. Conclusion

As a pivotal core course in applied chemistry, Principles of Chemical Engineering Experiments must undergo comprehensive reforms to meet emerging engineering demands. By constructing collaborative university-enterprise systems, diversifying pedagogical strategies, integrating ideological-political education, and upgrading faculty capabilities, applied chemistry programs can cultivate professionals with robust theoretical foundations and exceptional practical skills.

Acknowledgements

The authors gratefully acknowledge the Project of Jiangsu Higher Education Institutions of China (No.24KJA150005) and Qing lan Project of Jiangsu Province of China.

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