Discussion on the Teaching Reform of *Organic Chemistry* Combining Theory with Practice

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Abstract: *Organic Chemistry* constitutes an indispensable foundational discipline within the chemical engineering curriculum, distinguished by its equal emphasis on theoretical depth and practical proficiency. Yet the inherently abstract nature of topics—such as molecular architectures and mechanistic pathways of organic compounds—coupled with limited instructional hours, renders conventional lecturing insufficient to captivate student interest, often resulting in suboptimal mastery of essential concepts. In response to these challenges, this paper proposes a comprehensive reform addressing curriculum content, pedagogical strategies, and instructional tools. By intricately weaving theoretical constructs into hands-on practice, students can internalize abstract principles through active engagement, thereby actualizing the ethos of "learning by doing". This integrative approach aspires to elevate both the quality and the effectiveness of *Organic Chemistry* education.

Keywords: Organic Chemistry; Teaching Reform; Theory and Practice; Instructional Methodologies

1. Current Status and Challenges in *Organic Chemistry* Instruction

Organic Chemistry occupies an indispensable position as a foundational discipline within programmes such as Chemical Engineering and Technology and Energy Chemical Engineering. This course rigorously examines the structures, nomenclature, synthetic methodologies, physical and chemical properties, reaction pathways and mechanisms, applications, and stereochemical nuances of organic compounds. It simultaneously equips students with the essential underpinnings required for future pursuits in fine-chemical industries—spanning chemical manufacturing to pharmaceuticals. Thus, the significance of *Organic Chemistry* resonates profoundly across both academic curricula and industrial practice.

The pedagogical landscape of *Organic Chemistry* presents distinctive hurdles. Firstly, each module brims with a multitude of concepts, while the study of reaction mechanisms remains inherently abstract and elusive, rendering sustained student engagement and comprehensive assimilation exceptionally challenging. Secondly, the curriculum is meticulously sequenced; mastery of early chapters is prerequisite to grasping subsequent material, so any lapse in foundational understanding directly impairs one's ability to progress[1]. Lastly, the prevailing instructional paradigm skews heavily toward theoretical exposition, often neglecting to forge meaningful connections with practical applications, thereby fostering a disjunction between theory and practice[2]. Compounding these issues, today's learners—immersed in an era of instantaneous, information-rich connectivity—are habituated to rapid, fragmented knowledge "snacks", which engender a superficial learning stance and erode their capacity for sustained focus[3].

Hence, it is of paramount importance to devise pedagogical strategies that enable students to internalize and recall the intricate web of organic reactions and mechanisms, while seamlessly translating theoretical insights into hands-on competence—truly embodying the ethos of "learning by doing".

2. Specific Strategies for *Organic Chemistry* Teaching Reform

2.1 Integration of Digital Teaching Tools

To address the constraints of limited contact hours, the abundance of material, and the often abstruse nature of mechanistic content in Organic Chemistry, we propose harnessing a rich spectrum of modern information technologies. By employing platforms and resources such as Xuexitong (LearningPass), Rain Classroom, instructional videos, Flash animations, graphic narratives, illustrative images, online course repositories, QQ, WeChat, and email, instructors can craft a blended learning environment that weaves together online and face-to-face engagement. Anchored in an inquiry-based pedagogy, this approach positions students at the heart of the learning process, while the instructor assumes the role of organizer and guide. The instructional sequence—“pose questions → analyze problems → devise solutions”—nurtures students’ propensity for critical inquiry, adventurous exploration, and innovative thinking. In doing so, it surmounts the traditional model’s challenges of excessive difficulty and the disconnect between theoretical knowledge and practical application[4].

2.2 Facilitating Open Access to the Organic Chemistry Laboratory for Practical Application of Theoretical Concepts

Organic Chemistry is fundamentally an experimental discipline, and laboratory work comprises a cornerstone of its instruction. Laboratory exercises play a crucial role in cultivating students’ holistic chemical literacy and, through hands-on engagement, ignite their passion for theoretical principles—thus forging a dynamic interplay between concepts and practice[5]. In the lab, learners synthesize foundational organic-chemistry principles and techniques as they confront intricate engineering challenges—including design of synthetic protocols, separation and purification strategies, analytical characterization, and data interpretation—culminating in the formulation of well-substantiated conclusions. Such experiential learning not only hones students’ critical-thinking and problem-solving abilities and manual proficiency but also fosters a spirit of inquiry and a disciplined, empirical scientific ethos. For example, when studying the properties and synthesis of ethyl acetate, students might perform the esterification of acetic acid with ethanol in situ. This direct experimentation vividly reveals the reaction’s reversible nature, encouraging learners to ponder its mechanistic nuances and explore methods to enhance conversion efficiency—thereby deepening their intuitive understanding of otherwise abstract reaction pathways.

2.3 Incorporation of Real-World Case Studies

Amid the swift march of industrialization, environmental degradation—particularly chemical pollution—has emerged as a pressing global crisis. Given organic chemistry’s intrinsic connection to ecological stewardship, it is imperative to weave the principles of green chemistry into our teaching. Doing so deepens students’ appreciation of the inextricable bond between chemical processes and environmental well-being, nurtures their sense of ecological responsibility, and equips them to champion sustainable practices in their future endeavors[6]. By introducing relatable, everyday examples—such as instances of air, water, and soil contamination—instructors can bridge the gap between abstract reaction mechanisms and their tangible implications. This approach not only captivates student interest but also underscores the practical significance of green chemistry principles. Collaborative discussions around commonplace pollution scenarios empower learners to contemplate preventive and remedial strategies, inspiring them to propose and adopt eco-friendly production methods. Through this experiential lens, students cultivate both environmental consciousness and innovative problem-solving skills, laying a solid foundation for the study and practice of “Green Chemical Engineering”.

2.4 Establishment of a Virtual Simulation Laboratory

By harnessing advanced virtual-reality and simulation technologies to create a fully digitalized laboratory environment, we can surmount the inherent limitations of traditional *Organic Chemistry* practice—particularly in terms of preparatory efficacy and safety. Such a virtual lab affords an intuitive, personalized, and secure learning experience. For instance, nitration reactions often carry explosive hazards; through an integrated software platform, students can visualize and monitor reaction parameters in real time, rendering complex organic processes both vivid and comprehensible. Learners are empowered to design their own experimental protocols and conduct investigations within this risk-free virtual realm—experiencing the thrill of “explosive” organic synthesis without ever compromising safety.

2.5 Integration with Industry

University instruction in *Organic Chemistry* ought to be seamlessly intertwined with industrial practice by establishing robust industry–academia–research collaboration platforms, fostering deep synergies among production, scholarship, and innovation, and guiding students toward careers in industry and entrepreneurial ventures[7]. To this end, instructors should conduct field visits to chemical enterprises—consulting human-resources and technical managers, interviewing alumni employed in the sector, and conferring with chemical-education specialists—to map out corporate talent structures and discern the precise organic-chemistry competencies demanded by various roles. Gathering these "must-have" and "adequate" skill requirements for graduates across diverse specializations enables the formulation of curriculum standards that are finely attuned to professional training objectives. Once the core course content has been identified, it can be organized into discrete modules aligned with distinct knowledge domains. This approach preserves the systematic rigor of traditional pedagogy—ensuring comprehensive coverage—while also empowering the design of work-process–based teaching projects informed by genuine industry tasks uncovered during corporate surveys or by faculty research initiatives. Such authentically grounded projects guarantee practical relevance and facilitate a seamless integration of theory and practice[8].

Concrete industrial case studies act as beacons illuminating the often-abstract realm of organic synthesis, transforming complex molecular architectures, reaction mechanisms, and chemical equations into vivid, relatable phenomena that spark students' curiosity and thirst for knowledge[9]. The tight fusion of theoretical instruction with real-world practice not only elevates students' comprehensive abilities and hands-on skills but also invigorates their academic engagement. Beyond serving as a pedagogical innovation, this integration represents a powerful means of cultivating talent equipped to meet modern societal demands. It enriches learners' practical acumen, deepens their conceptual understanding, and fosters interdisciplinary cross.

2.6 Fostering Research Proficiency

Science stands as the bedrock of human progress, yet traditional pedagogy often remains divorced from authentic inquiry. Therefore, seamlessly intertwining scientific research with theoretical instruction is essential, both to ignite students' intrinsic motivation and to cultivate their capacity for rigorous scientific reasoning[10]. Given the inherently applied character of organic chemistry, embedding research-oriented tasks that align with core concepts not only reinforces comprehension but also vividly demonstrates how the discipline underpins advanced study and future professional endeavors.

Instructors might assign after-class scholarly projects—for example, forming student teams to select a research topic, conduct literature reviews, collect and analyze data, and compile their findings into a comprehensive written report accompanied by a narrated slide presentation. Teams would then present their research rationale, methodology, and significance, reflecting on how they bridged theoretical principles with empirical investigation and offering personal insights and recommendations. Alternatively, students may collaborate directly with faculty mentors on innovative experimental studies, applying classroom knowledge in a practical context and engaging in iterative cycles of hands-on experimentation, critical reflection, and creative problem-solving. This pedagogical paradigm fully mobilizes learners' autonomy and inventiveness, equipping them with the interdisciplinary skills and scientific acumen demanded by modern society. It deepens their mastery of organic chemistry, nurtures a lasting passion for research, and lays the groundwork for tangible scholarly achievements—such as publishing papers, filing patents, or competing in academic contests—thereby amplifying their innovative potential.

3. Conclusion

By examining a range of reform measures—namely the integration of digital teaching tools, judiciously expanded access to *Organic Chemistry* laboratories, the incorporation of real-world case studies, the creation of virtual simulation environments, closer alignment with industry, and the cultivation of students' research skills—this paper proposes a holistic transformation of *Organic Chemistry* instruction. These initiatives directly address existing challenges in curriculum content, pedagogical approaches, and instructional media. By weaving theoretical concepts into hands-on practice, students can internalize abstract principles through experiential learning, thereby realizing the ideal of “learning by doing” and elevating both the quality and effectiveness of *Organic Chemistry* education.

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