

# Research on the Construction of Industrial Catalysis Course Under the Background of Specialty-Innovation Integration

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**Abstract:** “Specialty-innovation integration” is a positive response of higher education to economic and social development needs, and it is also an inherent requirement for the reform and development of higher education. This paper discusses the construction of an “industrial catalysis” curriculum system under the background of specialty-innovation integration. Overall, it raises students’ comprehensive quality from three aspects, including teaching content, teaching method, and the concept of specialty-innovation integration, aiming to cultivate students as the innovative talents required by the development of the era for national and regional development.

**Keywords:** Specialty-innovation integration; Industrial catalysis; Innovation; Entrepreneurship; Professional education

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## 1. Introduction

Accelerating the reform of innovation and entrepreneurship education in colleges and universities is an urgent need for the country to implement the innovation-driven development strategy and promote economic upgrading. It is also an important measure to promote comprehensive education reform and improve the quality of talent training <sup>[1]</sup>. The “Implementation Opinions on Deepening the Reform of Innovation and Entrepreneurship Education in Colleges and Universities” was released in 2016, pointing out that it is necessary to promote the organic integration of professional education, and innovation and entrepreneurship education, and to reconstruct and develop the dual-creation education resources of professional courses <sup>[2]</sup>. In 2019, the General Office of the Ministry of Education issued the “Demonstration Universities on Deepening Innovation and Entrepreneurship Education Reform 2019.” The Notice on Annual Construction Work further emphasizes the integration of innovation and entrepreneurship education throughout the entire process of talent training

and requires the construction of a “specialized and integrated” demonstration course <sup>[3]</sup>. In the context of innovation-driven, vigorously promoting innovation and entrepreneurship education is a positive response of higher education to the needs of economic and social development, and it is also an inherent requirement for the reform and development of higher education. The integration of specialization meets the requirements of economic development in the innovation-driven era. There is a need for professional education reform, innovation, and entrepreneurship education reform. It promotes the high-quality development of innovation and entrepreneurship activities.

Innovation integration refers to integrating professional education and innovation and entrepreneurship education. It is based on professional education, integrating innovation and entrepreneurship knowledge and skills into professional knowledge, and achieving the teaching concept and mode of value output through the co-creation of teachers and students <sup>[4]</sup>. Excavating and enriching the innovation and entrepreneurship education resources of various professional courses, organically integrating the teaching of professional knowledge with the training of innovation and entrepreneurship skills, and carrying out the reconstruction of professional courses of “specialization and integration” are essential breakthroughs in the reform of professional education in the era of knowledge economy. It is an effective measure to deepen the reform of innovation and entrepreneurship education.

Curriculum is the implementation unit and carrier of talent training, and classroom teaching is an important way to integrate mass entrepreneurship education and professional education. Higher education institutions urgently need to accelerate the deep integration of dual-creation education and professional course teaching, develop professional courses rooted in the concept and content of dual-creation, infiltrate <sup>[5]</sup> the concept of dual-creation into every unit of the course, and fully stimulate students’ innovative and entrepreneurial potential. This article discusses the reconstruction of the curriculum teaching system of the course “Industrial Catalysis” under the background of creative integration and based on the needs of students’ employment, professional education, and long-term development, in order to cultivate students’ professional skills and quality from the teaching content, teaching methods, and creative integration teaching from three aspects of the concept. This can break through the weak links of talent training and comprehensively improve the quality of talent training.

## 2. Reform of teaching content

In the current teaching of industrial catalysis course, most teachers focus on the theoretical system and knowledge structure of the course without combining the current relevant professional characteristics and development trends, thus ignoring the cultivation of students’ innovative ability and thinking <sup>[5]</sup>. In the context of “expertise and innovation,” students must have professional knowledge skills and innovative thinking. Therefore, based on the needs of students for entrepreneurship and employment, the needs of colleges and universities for professional training, and the needs of enterprises and society for professional talents, the teaching content of industrial catalysis and innovation elements are combined to meet the training goals of applied innovative talents and prepare students for employment and entrepreneurship.

Based on teaching the principles of catalysis, the industrial catalysis course guides students to understand the chemical nature of the catalytic process, the essential requirements and characteristics of industrial catalysis technology, and the performance, preparation, and application methods of common industrial catalysts. It also helps students to understand modern catalysis research methods, combine traditional industries with modern industries based on current development hot spots in the catalysis industry, organically integrate the learning of industrial catalysis professional knowledge with innovation and entrepreneurship ability training, and apply the

knowledge learned to analyze and solve practical problems in catalysis research.

The main teaching content of “Industrial Catalysis” includes introduction to industrial catalysis, structural basis of solid catalysts, adsorption, catalysis and heterogeneous catalysis, complex catalysis and polymerization catalysis, environmental catalysis and environmental-friendly catalysis technology, catalysis for new energy and fuel industry technology. In addition, it also includes biocatalysis technology, fine organic synthesis and catalytic strategy technology for production of drugs and modulators, microkinetic analysis and design of industrial catalysts, preparation and use of industrial catalysts, evaluation of industrial catalysts and macroscopic physical property testing, frontiers of industrial catalysis research, an introduction to catalyst characterization technology, as well as innovation and entrepreneurship education, and corporate experience sharing in the field of industrial catalysis.

Based on the characteristics of the industry, the focus of the industrial catalysis teaching content is through joint teaching by professional and industry experts and guided by fundamental theories, as well as actual industrial catalysis technology involved in the coal chemical industry, petrochemical industry, energy chemical industry, environmental chemical industry, fine chemical industry, combined with cutting-edge catalysis research and integration into professional learning. These can help students to become familiar with the knowledge system in this professional field and the actual career needs of enterprises, and stimulate students’ interest and ability in innovation, entrepreneurship, and professional research and development (R&D) in industrial catalysis.

### **3. Innovation of teaching method**

The industrial catalysis courses are still in the “full class” teaching mode. Teachers instill one-way teaching, and students passively accept it, which has led to many students needing more motivation to learn and concentrate. This teaching method will inevitably hinder the growth of students in industrial catalysis course, which could be more conducive to achieving the teaching goal of industrial catalysis. Implementing innovative integrated education concepts can promote the transformation and upgrading of traditional classrooms, thereby changing “teaching knowledge” to “solving problems and creating value.” The role of students in the classroom changes from “listeners” to “participants.”

In the process of industrial catalysis teaching, the theme of the activity is determined according to the specific knowledge and skill requirements involved in several typical industrial catalysis technologies. By organizing flipped classrooms, homework, group discussions, debates, and other activities, we emphasize the leading role of students, encourage them to communicate and share, and cultivate their sense of competition and cooperation, problem solving skills, planning and designing skills, and teamwork, thus highlighting the enthusiasm and initiative of students, and improving students’ classroom participation and teaching effectiveness.

For example, 4–5 students can work as a group, taking Fischer-Tropsch synthesis technology in industrial catalysis as the topic. Through literature research and brainstorming, students make group reports and conduct PowerPoint presentations (PPTs) in class. Through this, students can deepen their memory of this knowledge point, form their knowledge system, and expand their innovative thinking skills.

Combining theory with practice is also required in the teaching. Practical activities are essential to improving students’ innovation and entrepreneurship capabilities. However, most of the current industrial catalysis courses focus on teaching theoretical knowledge, and require more practical guidance. As a result, students cannot promptly internalize the basic theoretical knowledge learned, and consequently, the cultivation

of students' abilities to create and think is ignored. Under the background of professional integration, it breaks the convention of teaching experimental practice courses and theoretical courses separately, deeply integrates industrial, experimental practice, and catalysis basic knowledge theoretical courses, and infiltrates engineering practice cases into theoretical teaching, which genuinely achieving the integration of industry, academia and research, and innovating teaching method. For example, the experimental practice on dehydrogenation of ethylbenzene to styrene combines the theoretical course on industrial catalysis. The teacher introduces basic theoretical knowledge such as catalytic principles, catalysts, and reaction devices in class to lay a foundation for students to understand the experimental practice. Through understanding and practical of the ethylbenzene dehydrogenation to the styrene training base, the theoretical knowledge learned can be applied to actual industrial production. Through the combination of theoretical teaching and practical activities, students will develop the professional skills and mass entrepreneurship capabilities required, and meet the needs for future entrepreneurship and employment.

Online and offline hybrid teaching is another innovation method. Under the "Internet +" development concept, online and offline hybrid teaching modes are carried out for industrial catalysis courses. The teaching content of similar courses at home and abroad needs to be updated, and the relevant video resources are minimal. At the same time, there is a lack of innovation in teaching concepts and methods, and a serious shortage in "specialization and integration." With the help of various platform tools such as online teaching, network teaching, and mobile teaching, such as DingTalk, Tencent Classroom, massive open online course (MOOC), and Rain Classroom, students' interest in learning is fully stimulated, and the quality of classroom teaching and student participation are improved. Moreover, through mobile terminal-assisted teaching activities, flexible and diverse teaching forms, such as role-playing, situational simulation, and other forms are achieved, to create a new type of open classroom that is "student-led, teacher-assisted" and to cultivate high-quality, high-participation professional. "Golden Class" allows each class to become a home for students to solve problems and create value, stimulates students' motivation and enthusiasm for learning, and comprehensively cultivates students' ability to create mass entrepreneurship and solve problems systematically. In addition, joint lectures by experts from schools and enterprises can be achieved by combining online and offline resources.

#### **4. Implementation of specialized integrated teaching concepts**

Specialty-innovation integration is oriented toward innovation and entrepreneurship, focusing on cultivating innovative talents in line with the law of knowledge output in the era of the knowledge economy. It can effectively promote the organic connection of the education and professional chains with the industrial and innovation chains<sup>[6]</sup>. The construction of industrial catalysis courses under specialized innovation integration aims to fully integrate innovation and entrepreneurship elements into course teaching and further strengthen the connection between course teaching and industry. Industrial catalysis courses are closely related to innovation, entrepreneurship, and employment. The course organically integrates cutting-edge research methods, engineering practice innovation, and entrepreneurship education into professional education, which helps to enhance students' professional R&D interests and engineering capabilities, thus lays a solid foundation for students to engage in professional-based innovation and entrepreneurship activities<sup>[7]</sup>.

Based on this, from the two aspects of classroom and extracurricular entrepreneurship activities, we fully implement the concept of specialized and integrated teaching and cultivate the sustainable development of teachers and students.

## 5. Ability in continuous development

In classroom teaching activities, introducing actual industrial production problems and specific tasks, and allowing students to listen to the lectures with questions help students to understand the current status of industry and enterprises <sup>[8]</sup>. Moreover, in the process of completing specific tasks, constantly solving specific problems, and summarizing experience, students' entrepreneurial awareness, innovative spirit, and entrepreneurial ability are cultivated, and students' thinking habits of constantly creating value are formed, which prepares students for future employment and entrepreneurial activities in terms of knowledge and skills, methods, and awareness <sup>[9]</sup>.

Teachers play an irreplaceable and vital role in cultivating innovative talents. Therefore, after-class entrepreneurship and innovation activities are carried out at the teacher and student levels. On the one hand, it involves teaching teachers to consider the employment direction and subject research direction of students, focusing on industrial issues related to industrial catalysis, cooperating with enterprises to carry out applied research, encouraging and supporting teachers to serve as expert consultants to enterprises as scientific researchers, and promoting the transfer of laboratory scientific research results transformation <sup>[10]</sup>. On the other hand, students form project teams, simulate the establishment of companies, teacher-student studios, and maker centers, and actively participate in college student innovation and entrepreneurship training as entrepreneurial protagonists, and the four creations of "innovation, excellence, pioneering, and effectiveness" projects, and campus incubator projects. In addition, by organizing a series of corporate internship activities and a series of special lectures, the concept of professional integration is fully implemented into the teaching of industrial catalysis. Efforts are made to build a teaching environment and system that supports students to carry out innovative and entrepreneurial activities and promote the transformation of knowledge resources into knowledge capital conversion.

## 6. Conclusion

The organic deep integration of professional education and innovation and entrepreneurship education is the focus of innovation and entrepreneurship education reform in colleges and universities. This paper discusses the course construction of "Industrial Catalysis" under the background of specialty-innovation integration. It reconstructs the teaching system of the course from three aspects, which are teaching content, teaching method, and teaching concept of combination of professional education and innovation and entrepreneurship education, and effectively explores how to cultivate innovative talents, comprehensively improves students' professional skills and innovative and entrepreneurial qualities, and achieves the cultivation of innovative talents.

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