Exploration on University-industry Collaboration Teaching of Chemical Materials Based on the Cultivation of Applied Talents

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Abstract: This article focuses on the teaching reform of university-industry collaboration in the cultivation of applied talents in chemistry material class. In view of the problems in the traditional education model, such as the disconnection between industrial demand and teaching objectives, the lack of practical teaching resources and the lack of quality assurance system, a trinity of "demand-oriented-collaborative operation-quality assurance" cooperative education mechanism between schools and enterprises is constructed. This article proposes a dynamic updating model of teaching objectives based on industry demand analysis, designs a "university-industry-third-party organization" dual-subject collaborative mechanism, and constructs a multi-dimensional quality assurance system covering process assessment, competency-based assessment and data-driven adjustment. This mechanism can effectively improve students' practical operation ability, innovative problem solving ability and job adaptability, enterprise participation and satisfaction can be significantly improved, and graduates' employment competitiveness in the fields of green catalytic technology and new material research and development can be enhanced. This research provides a replicable and popularized reform path for the cultivation of applied talents in material class, and promotes the transformation of the integration of production and education from formal cooperation to deep collaboration.

1. Introduction

At the moment when the scientific and technological revolution and industrial transformation are deeply intertwined, the field of chemical materials, as the core support of national strategic emerging industries, is undergoing profound changes from traditional manufacturing to intelligent and green transformation [1]. This process not only gave birth to the demand for new materials research and development, green synthesis technology, intelligent manufacturing and other cutting-edge technologies, but also put forward brand-new requirements for practitioners' knowledge structure, practical ability and innovative literacy [2]. However, there are still some structural contradictions such as "emphasizing theory but neglecting practice" and "discipline orientation lags behind industry demand" in the talent training mode of material class in universities. As a result, graduates have obvious shortcomings in engineering practice ability, problem solving ability and industry adaptability, and it is difficult to meet the urgent demand for compound applied talents in industrial transformation and upgrading [3].

As the key path to solve this dilemma, the core value of university-industry collaboration teaching lies in the deep coupling mechanism between "education chain" and "industrial chain" [4]. By integrating enterprise real projects, technical standards and management norms into the teaching process, not only can theoretical knowledge be effectively transformed into practical ability, but also students' innovative ability to identify problems and design solutions in complex engineering situations can be cultivated [5]. This training mode is essentially a reconstruction of the traditional educational ecology, emphasizing the transformation of the educational subject from a single school to a dual subject of "university-industry", the return of the educational goal from knowledge transfer to ability generation, and the extension of the educational process from closed classroom to open practice field [6]. This article focuses on the theoretical construction of the university-industry collaboration teaching in material class, aiming at systematically analyzing the value connotation

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and operation law of the cooperative education of production and education, and putting forward the reform path of "demand-oriented, dual-subject and ability-oriented".

2. Multi-dimensional value analysis of university-industry collaboration teaching

The theoretical foundation of university-industry collaboration teaching is deeply rooted in the interdisciplinary academic soil, and its core value can be systematically analyzed from three dimensions: educational ecology, competency-based education theory and dual education theory.

From the perspective of educational ecology, university-industry collaboration teaching is essentially a practical exploration of building an "education-industry" symbiotic system [7]. In the traditional education mode, schools, as independent educational subjects, have a natural separation between knowledge production and industrial practice. The university-industry collaboration embeds the education process into the industrial ecosystem by introducing real enterprise projects, technical standards and management norms, and forms a dynamic adaptation mechanism between knowledge production and industrial demand. This symbiotic relationship not only promotes the optimal allocation of educational resources, but also promotes the paradigm transformation of educational objectives from cultivating "academic talents" to "industrial applicable talents".

Competency-based education theory provides a goal orientation for university-industry collaboration teaching. This theory emphasizes that education should focus on the generation of students' ability to solve practical problems, rather than the simple accumulation of knowledge [8]. Through project-based learning, engineering practice and other teaching links, university-industry collaboration transforms the real tasks of enterprises into teaching situations, so that students can naturally form core abilities such as problem identification, scheme design and technical implementation in the process of completing projects. This process of ability construction is essentially a subversion of the traditional "teacher-centered" teaching model and a shift to a "student-centered" educational paradigm.

The dual education theory provides an institutional reference for university-industry collaboration teaching [9]. Dual education in Germany has realized the deep integration of theory and practice through the sharing of responsibilities between schools and enterprises. Although there are differences between China's national conditions and German's, the core principles of dual system theory, such as "dual subjects cooperate to educate people" and "ability standard meets industrial demand", provide localization enlightenment for China's university-industry collaboration teaching. Dual system theory emphasizes the irreplaceability of enterprises as the main body of education, and its participation in the whole process of curriculum design, practical teaching and quality assessment is the key to ensure the adaptability of personnel training.

3. Mechanism design: the logical framework of cooperative education between schools and enterprises

The core of university-industry collaboration teaching is to build a sustainable collaborative education mechanism, and its logical framework needs to be developed around three dimensions: "demand docking-collaborative operation-quality assurance". Through theoretical deduction and mechanism design, this section puts forward the complete path of university-industry collaboration education, supplemented by a specific model (see Table 1).

3.1. Demand-oriented driving mechanism: the transformation from industrial demand to teaching objectives

The starting point of university-industry collaboration teaching is to establish a dynamic mapping relationship between industrial demand and teaching objectives. In the traditional education model, teaching objectives are often based on the setting of subject knowledge system, which is out of line with the actual needs of the industry. The demand-oriented driving mechanism requires accurate docking through the following paths:

(1)Industrial demand analysis model

Establish a three-dimensional analysis framework of "post ability demand-technology development trend-policy orientation", and form an industrial demand database by means of industry association research, enterprise expert interview and post ability map drawing.

(2)Dynamic updating mechanism of teaching objectives

According to the industrial demand database, a three-level teaching target system of "course module-ability unit-knowledge point" is constructed. Every semester, the teaching objectives are dynamically adjusted through the joint discussion between the technical director of the enterprise and the school teachers.

Table 1: Demand Alignment Model for University-Enterprise Collaborative Talent Cultivation

Dimension	Specific Content	Implementation Subject	Cycle
Industry Demand Analysis	Mapping of job competence profiles, assessment of technological trends, interpretation of policy documents	Enterprise technical experts, industry associations	Annual
Teaching Objective Transformation	Disassembly of competence modules, mapping of knowledge points, reorganization of course modules	University teachers, enterprise mentors	Semester
Dynamic Update Mechanism	Feedback on enterprise technical demands, adjustment meetings for teaching objectives, update of teaching resources	Collaboration of dual subjects (university and enterprise)	Real-time

3.2. Coordination mechanism of dual subjects: responsibility sharing and benefit sharing

The core of university-industry collaboration education is to establish the responsibility sharing and benefit sharing mechanism of "university-industry" dual subject, and its key design includes: role positioning and responsibility division, benefit sharing and incentive mechanism. Among them, the school is responsible for basic theory teaching, curriculum system design and student management; Enterprises provide practical scenarios, technical guidance and internship opportunities; Third-party organizations (such as trade associations) are responsible for standard setting, quality assessment and resource coordination.

In the aspect of benefit sharing and incentive mechanism, a trinity benefit sharing mechanism is established, which includes "enterprise participation cost compensation", "income distribution of students' practical achievements transformation" and "government special subsidy for integration of production and education". For example, enterprises can obtain intellectual property benefits through the transformation of technological achievements, and schools can obtain resource support through enterprises donating equipment or building laboratories.

3.3. Teaching mechanism of ability generation: project-based learning and practical situation construction

Ability generation is the ultimate goal of university-industry collaboration education, and the design of its teaching mechanism needs to focus on the following two points:

(1)Project-based learning design

The real enterprise project is decomposed into teaching modules. For example, the project of "green synthesis process design" can be divided into subtasks such as catalyst screening, reaction condition optimization and waste disposal, and students can gradually build their abilities by completing subtasks.

(2)Construction of practical situation

Establish a three-level practice system of "virtual simulation-pilot platform-enterprise production line". For example, in the teaching of "Synthesis of Bio-based Materials", students first simulate the technological process through virtual simulation software, then carry out small-scale experiments on the pilot platform of enterprises, and finally enter the production line of enterprises to complete real production tasks.

4. Quality assurance: the construction of assessment system for collaborative education

The quality assurance of university-industry collaboration teaching is the core link to ensure the realization of educational goals. Its assessment system needs to break through the limitations of traditional "single-dimensional school assessment" and build a multi-dimensional quality monitoring network covering "process-result-dynamics". Through theoretical framework design and practical model construction, this section puts forward the quality assurance path of university-industry collaboration education (see Table 2 and Table 3).

4.1. Process assessment system based on dual subject

The traditional assessment system often takes "test scores" as a single indicator, ignoring students' ability growth in project practice. The process assessment system needs to establish a collaborative assessment mechanism of "university-industry" dual subjects, and its design points include: multi-dimensional assessment indicators and dynamic weight adjustment mechanism. Multi-dimensional assessment indicators divide the assessment dimensions into four categories: theoretical knowledge mastery, practical operation ability, teamwork literacy and innovative problem solving. In addition, the assessment weight is dynamically adjusted according to the project stage. At the beginning of the project, the weight of theoretical knowledge assessment accounts for 60%; In the middle of the project, the weight of practical operation ability will be increased to 70%; At the end of the project, teamwork and the weight of innovation results dominate.

Table 2: Process Assessment Index System for University-Enterprise Collaborative Talent Cultivation

Assessment Dimension	Specific Content	Assessment Subject	Weight Range
Theoretical Knowledge Mastery	Course examination scores, professional literature reading reports, application ability of technical principles	University teachers	30% - 60%
Practical Operation Ability	Norms of pilot-scale operation, experimental data processing, equipment maintenance ability	Enterprise mentors	40% - 70%
Team Collaboration Literacy	Rationality of project task division, cross-departmental communication ability, conflict resolution ability	Joint assessment by enterprise mentors and university teachers	10% - 20%
Innovative Problem-solving	Innovativeness of process optimization plans, ability to break through technical difficulties, patent achievement output	University-Enterprise Expert Committee	10% - 30%

4.2. Outcome assessment system based on competency

Results assessment should focus on "ability generation" and construct a closed-loop system of "ability standard-assessment tool-feedback mechanism". First of all, according to the industrial demand analysis model, the standard matrix of chemical material class competence is established,

and the specific requirements of core competence such as "green synthesis process" and "characterization of new materials" are defined. At the same time, diversified tools such as "project report review", "virtual simulation test" and "enterprise post practice assessment" are adopted.

Table 3: Resultant Assessment Tool Matrix for University-Enterprise Collaborative Talent Cultivation

Ability Type	Assessment Tool	Assessment Subject	Assessment Scenario
Theoretical Knowledge Ability	Course examinations, patent writing defenses	University teachers	Standardized examination rooms, defense rooms
Practical Operation Ability	On-the-job practical assessment in enterprises, virtual simulation tests	Enterprise mentors, third-party certification bodies	Enterprise production lines, laboratories
Innovative Problem-solving Ability	Project roadshows, technical proposal reviews	University-Enterprise Expert Committee	Academic lecture halls, review rooms

4.3. Dynamic adjustment mechanism based on data drive

Establish a "quality monitoring database" to collect students' ability development data, enterprise satisfaction feedback, industry technology trends and other information in real time. Through the data analysis model, the Quality Report of University-industry Collaboration Education is generated every semester, which provides decision-making basis for the adjustment of teaching objectives, the optimization of curriculum modules and the cooperation strategy of enterprises.

Through the design of the above assessment system, university-industry collaboration education can realize the paradigm transformation from "result assessment" to "process monitoring", from "single subject" to "dual collaboration", from "static standard" to "dynamic adaptation", and provide quality assurance for the training of applied talents in Chemical material class.

5. Conclusions

In this article, through the systematic study of the cooperative education mechanism between school and enterprise in Chemistry material class, a complete teaching reform framework is constructed from demand docking, cooperative operation to quality assurance, which provides an innovative path for the cultivation of applied talents. The research shows that the dynamic updating mechanism of teaching objectives oriented by industrial demand can effectively solve the problem of "separation of learning and application" in the traditional education model, and realize the accurate docking of teaching objectives and industrial demand through the three-dimensional analysis framework of "post ability map-technical trend research-policy orientation". The design of the dual-subject collaborative mechanism clarifies the division of responsibilities among schools, enterprises and third-party institutions in theoretical teaching, practical guidance and resource coordination, and stimulates the participation enthusiasm of both schools and enterprises through the benefit sharing model of "enterprise participation cost compensation-income distribution of students' practical achievements transformation-government special subsidies". In terms of quality assurance, the three-dimensional assessment system of "process assessment-competency-based assessment-data-driven adjustment" proposed in this article breaks through the limitations of traditional "result assessment", and realizes the whole process monitoring and accurate feedback of students' ability development through multi-dimensional assessment indicators, diversified assessment tools and dynamic weight adjustment mechanism.

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