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Exploration and Practice of Supply Chain Management Curriculum Reform Based on CDIO-OBE Teaching Design under the Background of New Liberal Arts

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Abstract: *Given the mismatch between the traditional supply chain management curriculum system and the professional ability requirements of the digital age, the lack of students' intrinsic motivation to learn, and the weak ability to innovate and start a business, this paper combines the current mainstream CDIO concept and OBE feedback teaching mode in engineering education, integrates the characteristics and trends of industry demand for supply chain management talents, and establishes a curriculum teaching system reform and innovation based on industry demand-driven, competency oriented, project carrier, and student-centered. The reform has achieved good application effects.*

Keywords: *CDIO; OBE; Supply chain management; Curriculum reform*

1. Introduction

As a new impetus reshaping the global economic structure and changing the global competitive landscape, the digital economy is driving the new business disciplines to integrate across disciplines, subjects, boundaries, and even fields through "new", "integrated", "penetrated" and "featured" thinking, to achieve collaborative optimization of industry-academia cooperation and innovation of personnel training system in the new era of business disciplines. Facing the new normal, new pattern, and new characteristics and requirements of talent demand in the development of the industry, the new business disciplines must break through the traditional education and teaching training mode, fully understand the industry background, development trend, and talent demand orientation, and reconstruct the digital economy professional talent training system and teaching model reform guided by competency requirements[1][2][3]. Supply chain management covers the design, operation and management optimization of the whole supply chain network from suppliers, manufacturers, distributors, retailers to final customers. It has become an effective new management concept and method for enterprises to enhance their commercial competitiveness in the 21st century, and has attracted much attention in developed countries such as the United States, Britain and Germany, and has become a national strategy. In China, supply chain management has also been highly valued by the state, local governments, academia, and industry. In 2017, the State Council officially issued the "Guiding Opinions on Supply Chain Innovation and Application". Affected by the COVID-19 pandemic, the Russia-Ukraine conflict, reverse globalization and trade protectionism of Western countries and other factors, supply chain disruptions and various "black swan events" have emerged one after another, and supply chain management is facing unprecedented challenges, which makes the training of supply chain management talents more urgent. In recent years, China's demand for supply chain management talents has shown an increasing trend year by year, and the total demand for supply chain management experts in China will reach about 6 million in the next 5 years. Supply chain management organically integrates multiple interdisciplinary knowledge such as supply chain management concepts, system optimization tools and methods, and modern information technology. The traditional curriculum teaching system has many teaching "pain points" such as the mismatch between the curriculum objectives and system and the professional ability requirements of the new era, the lack of students' intrinsic motivation to learn, and the weak ability to innovate and start a business. Therefore, with the smart, intelligent, and digital development of the supply chain, the current educational teaching mode cannot meet the professional advanced ability requirements, and it is necessary to re-examine how to truly stimulate students' personality, interests, specialties and potential, improve students' advanced technology application ability and innovation and entrepreneurship, to adapt to the professional ability requirements of the new

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era.

2. Introduction of CDIO and OBE

CDIO focuses on the overall process of teaching, establishes an integrated curriculum system with Conceive, Design, Implement, and Operate interconnected in the whole life cycle from product research and development to operation, guides students to actively participate in teaching and practice to learn engineering subjects, to cultivate students' personal scientific and technological knowledge, lifelong learning ability, team communication skills and the ability to build products, processes, and systems in social and corporate environments[1][2]. As an innovative achievement of international engineering education reform, educational philosophy, and model in recent years, CDIO has received extensive attention from the education and business sectors. Its prominent features are student-centered, and competency-oriented, emphasizing practicality and innovation, and highlighting teamwork awareness. OBE, namely Outcome-Based Education, first appeared in the basic education reforms in the United States and Australia. The OBE concept is based on the principle of "reverse design and forward implementation", using the professional ability requirements that enterprises and industries need students to achieve to determine the training objectives and programs of the discipline, intending to promote the improvement of comprehensive quality of professional talents and diversified talent training. In recent years, universities have also carried out a large number of teaching reforms and practical research on the CDIO model in theoretical courses, experimental courses, and course groups, and achieved certain teaching effects[4]. For example, Shi Xiaonan (2020) designed an innovative talent training model system for software based on the CDIO concept[5]; Gong Huanchen (2020)[6] designed a project-based teaching model under the CDIO and CBE concepts based on the smart transportation practice teaching platform jointly developed by the school and enterprises; Huang Faliang et al. (2021)[7] proposed experimental teaching methods oriented to theoretical innovation and project-driven with data thinking ability training as the core, introducing the CDIO concept. In the past few years, domestic scholars have carried out extensive teaching reforms, practices, and explorations based on the OBE concept, such as Song Xinyu et al. (2018)[8] and Wang Qi et al. (2021)[9] designed talent training programs and curriculum systems guided by OBE; Wang Chunjuan (2018)[10] formulated electronic commerce technology specialty personnel training programs and implementation approaches based on industry perspective and OBE connotation.

In summary, the CDIO concept and OBE reverse teaching mode have been gradually widely applied in education reforms. The combined teaching design of CDIO-OBE, that is, starting from the actual needs of enterprises, industriesand society fundamentally breaks through the traditional reform ideas, builds a demand-driven, school-enterprise cooperative model, accurately constructs the professional CDIO ability outline system under the background of new liberal arts, and refines the ability requirements into specific teaching practice projects that meet social needs and their characteristics. The school and enterprises utilize the project carrier to associate courses and knowledge, jointly design the CDIO ability realization OBE curriculum system for logistics majors, jointly build the teaching team to implement the cultivation process, and jointly evaluate the quality and effectiveness of the teaching output projects, integrating "enterprise recruitment" with "project cultivation". To a certain extent, it accurately targets the talent and technological needs of local logistics and related industrial clusters and ensures that the talent cultivation goals match the needs of enterprises, industries, and society. Therefore, combined with the academic structure and characteristics, and based on the current situation of professional talent needs under the background of new liberal arts, promoting higher education teaching reform with the combined educational concepts of CDIO-OBE has a certain reality and vision. It also provides an effective idea and reference for the reform of the supply chain management curriculum.

3. Overall Thinking of Supply Chain Management Curriculum Reform Based on CDIO-OBE Concept

Based on the drawbacks of the traditional teaching system, the supply chain management curriculum reform should form an integrated teaching system. Firstly, according to the requirements and standards of the CDIO ability training outline, it is important to establish a teaching outline system of supply chain management ability needs which bases on the needs of industry, enterprises, and social practice; at the same time, the teacher should construct supply chain management overall or partial ability projects which is suitable for teaching practice, and refine them into project carriers responding

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to teaching modules, using the project implementation in the teaching process to link the knowledge points of the course. Secondly, the logical relationship between the knowledge involved in ability realization, the status and role of each knowledge point in the whole teaching module, and its connection with other courses will be comprehensively analyzed and clarified. Finally, around the supply chain management ability goals, the project carrier to associate course knowledge will be utilized to design a teaching system based on the OBE concept. In a word, Overall thinking can be shown in Figure 1:

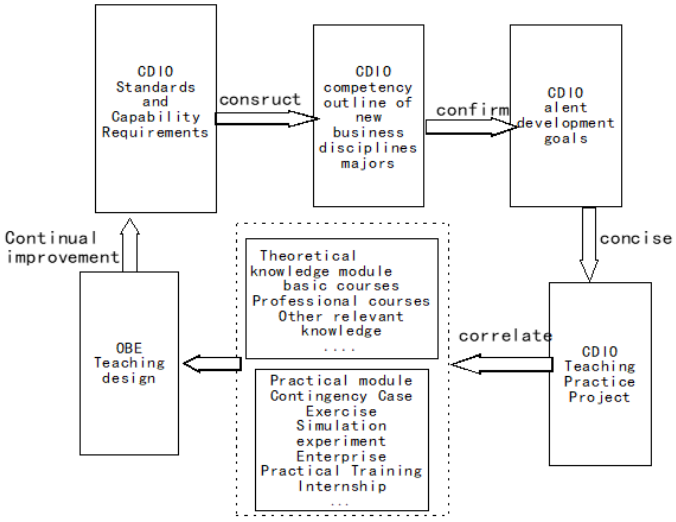

Figure 1. Overall thinking of curriculum reform

4. Specific Implementation Plan of Supply Chain Management Curriculum Reform

The specific implementation plan of curriculum reform based on CDIO-OBE combined concepts includes the following aspects:

(1) Curriculum reform goals. Taking the construction of "new liberal arts" as the guide, a high-level ability system and training goals of supply chain management curriculum should be constructed based on the needs of enterprise, industry, and social practice, and then the curriculum will be rebuilt, it includes four aspects: ① Constructing curriculum content based on competency-oriented and project-based, and using heuristic and case analysis to associate ideological and political content; ② Building an online resource library to meet differentiated, diversified and high-level needs; ③ Constructing a blended online and offline teaching model guided by competency, and introducing supply chain legend software and SCG software system which contains detailed data of large consulting companies for modeling and simulation to enrich teaching content, drive teaching activities, and deepen competency training; ④ Establishing a diversified assessment system guided by competency.

(2) Curriculum system reconstruction: It is key to reconstruct the curriculum system driven by demand, competency-oriented and project-based. Facing the development trend of "new technologies, new industries, new business forms, and new models", based on the "customized production principle", high-efficiency schools should coordinate with enterprises to take the professional qualification framework and digital resources of supply chain management as the support, to breakthrough key links and refine specific teaching projects in order to jointly construct diversified, multi-level, multi-category curriculum systems of theoretical parts, experimental parts, and practical parts with specific teaching projects as the carrier. The specific curriculum setting is based on the smart supply chain development mode under Industry 4.0, reconstructing the new era curriculum objectives that meet the talent training goal needs; The curriculum content is competency-oriented in the core positions of industry or enterprise logistics and supply chain management, based on the supply chain operation process, using cutting-edge intelligent logistics and supply chain information technologies, taking the SCOR model as the evaluation standard, constructing the "vertical through and horizontal integration" curriculum model, from the three levels of planning and scheduling, operation and execution, operation and support; Focusing on the "high-level, innovative and challenging" nature of the courses; Highlighting project practice driven, integrating theory and practice, online and offline, virtual simulation

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experiments and enterprise real cases. Arrange them in each teaching link according to the number of tasks, difficulty value, and competency advancement path, to improve the scientificity, practicality, and advancement of curriculum setting. The whole curriculum system consists of three parts: 1) The theoretical part, which mainly covers basic concepts, properties, management methods and techniques of supply chain management, uses the software operation of Supply Chain Legend to deepen students' understanding and mastery of basic theories and methods of supply chain management and the basic processes of supply chain operation; 2) The experimental part is divided into basic and scenario sections, which mainly include the basic theories and application scenarios simulation of specific processes planning, design and optimization in supply chain operation; taking 10 refined projects as the main line, divided into basic and scenario sections, mainly including supply chain planning, design and optimization The basic theory and application scenario simulation; 3) The practical application part uses the real enterprise case data provided by LLAMSOFT for immersive experience to solve the network design and optimization problems of complex supply chains, and the real cases of the International Supply Chain Modeling Competition are used for advanced training. The three parts are self-contained systems, advancing steadily, with deepening content layer by layer, thereby achieving the goal of competency advancement.

(3) Teaching model reform: Carry out small-class inquiry-based online and offline blended teaching to motivate students to study hard, study happily, and study effectively. First, according to the laboratory configuration, students are divided into classes with about 30 people to implement small class, one-to-one, face-to-face interaction; Second, fully implement "heuristic teaching, interactive communication, inquiry discussion, immersive experience" classroom teaching mode. Before class, make full use of the longing cloud classroom to require students to learn the guidance part according to the experimental purpose, which mainly introduces the basic modeling theory and methods of each teaching project, adopts the pre-class self-study method, which can enhance students' independent thinking and self-learning ability; In class, mainly take the teaching project in the cloud classroom as the carrier, from the basic, scenario, application sections, layer by layer in-depth simulation, each project has specific operation methods and cases. Students learn the theory and methods of supply chain management and operation through immersive experience of specific cases and real enterprise cases; At the same time, ideological and political content is infiltrated in the theoretical teaching part of the course according to the relevance of the course content. For example, from the perspective of supply chain management, the latest cases of some well-known Chinese enterprises participating in global supply chain operations are introduced into the classroom, analyzing the international situation, trade frictions, etc., emphasizing the responsibilities and responsibilities of Chinese enterprises in the global supply chain, so that students take the initiative to analyze and discuss successful Chinese corporate cases, and let the "Chinese corporate stories" take root in students' hearts; For another example, rural revitalization strategies can be mentioned by talking about the supply chain management of agricultural products, and different ideological and political contents are infiltrated in different teaching links, telling good stories and letting students comprehend Chinese ideology. The OBE reverse teaching concept runs through the whole teaching process, with school-enterprise cooperation and online and offline blended teaching as innovative means; With the "45-minute classroom" teaching reform as the traction, implement the "whole element classroom teaching reform, all-round promotion of personalized training", and promote the new design and practice of concepts, methods, technologies and evaluations of classroom teaching reform.

(4) Construction of a diversified dynamic evaluation system. According to the requirements of the curriculum objectives, establish a dynamic assessment and evaluation mechanism of full-process academic examination, diversified evaluation criteria, and diversified assessment methods, breaking the drawback of final exam scores determining grades, making rote learning and barely passing become "sealed memories". Combined with the online and offline blended teaching mode, the assessment methods mainly include theoretical knowledge (computer-based test), experimental modeling and simulation, and curriculum design; Adopt open-ended and non-standard reference answers; The scores are determined by the theory test + 10 case simulation reports + final course design practical operation. Students watch the instructional videos online before class and complete the theoretical self-test questions online; In class, students complete experimental simulation according to the case data and learning task points, and submit the experimental results online (the program, results report, experimental result analysis, etc. of each classroom scenario simulation task); Stage learning outcomes and final comprehensive outcomes (enterprise case practical training curriculum design) are submitted online or offline. Different measurement and evaluation criteria are set for the data, stage results, and final comprehensive scheme design involved in the teaching process, and the final learning scores of the course are recorded in a certain proportion according to the theory learning, virtual simulation

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experiment result analysis, and final curriculum practical report, providing a reliable scientific basis for subsequent reflection and continuous improvement of teaching. Learning evaluation adopts a combination of online data and offline recording evaluation; process and result evaluation; Constructs a three-dimensional, multi-dimensional, and traceable evaluation system to comprehensively evaluate students' learning. Composition of process and result evaluation ratio is shown in table 1.

Table 1 Composition of Process and Result Evaluation Ratio

Course objectives	Composition of grades					
	daily performance			Mid-semester (Theory test)	Final Exam (Practical Cases of Enterprises)	Comprehensive score
	Classroom Interaction and experimental report	task	Experimental Theory test			
Course objectives1	10%			20%	5%	35%
Course objectives2	5%			5%	25%	35%
Course objectives3	5%			5%	20%	30%
Comprehensive score	20%			30%	50%	100%

5. Implementation effectiveness and continuous improvement

1) Implementation effectiveness

In the process of reform and innovation, we have always adhered to the perspective of "new liberal arts" and the standards of "excellent courses", and achieved good results. The lecturer's teaching effect in this course is outstanding and highly evaluated by students. The reformed Supply Chain Operation and Simulation as the experimental practical teaching part of the supply chain management course was identified as a national first-class simulation course in 2020 and was approved to establish a smart supply chain management micro-specialty. The teaching team has repeatedly offered open courses in the school with the contents of this curriculum reform and held lectures and teaching salons on and off campus with "teaching innovation" and "small group activity design" as the themes. Based on the data, cases, and methods formed by the curriculum reform, the teaching team has compiled the simulation experiment textbook for Logistics and Supply Chain Management and related teaching materials for Digital Supply Chain Management. Students have obtained 5 national projects and more than 10 provincial projects with this curriculum project practice as the carrier. Based on the virtual simulation experiment platform jointly built by the school and enterprises, team members have led students to participate in various competitions, such as graduate mathematical modeling competition, national college student mathematical modeling competition, national college student logistics design competition, national college student software design competition, international supply chain modeling competition, "Internet + innovation and entrepreneurship" competition, and have won more than 20 national, provincial and school-level awards.

2) Continuous improvement

There are mainly two problems in the whole supply chain management curriculum teaching innovation reform. First, the whole experiment process is complicated and there are a lot of issues to consider. Students' theoretical knowledge must be solid, but some students need to complete group tasks for multiple courses, which puts too much pressure on them and affects the learning effect. In future courses, appropriate experiment project time arrangements and task adjustments should be made to ensure completion quality. Secondly, the interactive functions of the Longfeng cloud classroom can meet the needs of the course but do not support posting video files after class, which restricts after-class expansion. In future reforms, we will continue to explore other technical means to improve teaching quality.

In summary, the educational approach centers on students, establishing a framework driven by demand, oriented toward skills, and facilitated through projects, emphasizing the "Four Integrations" in teaching content. These integrations encompass the fusion of interdisciplinary and cross-curricular knowledge, the amalgamation of research outcomes with teaching content, the synthesis of theoretical

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concepts with professional positions, and the blending of ethical education with case discussions. This approach aims to reconstruct an innovative curriculum system, breaking free from the confines of traditional syllabi. Real-time infusion of dynamic knowledge is encouraged, allowing students to engage in hands-on activities, nurturing their innovative thinking and practical abilities. The goal is to align talent cultivation with the contemporary industry's demands, enabling students to meet the requirements of new-era professional positions. Through industry collaborations, students have the opportunity to grasp the latest trends in the industrial sector, fostering an academic atmosphere within undergraduate classrooms. This approach enhances students' abilities to address real-world supply chain issues .concerning businesses, industries, and society. It achieves a seamless integration of creativity and research, progressive skill development, and the balanced pursuit of professional ethics. Ultimately, this teaching reform not only stimulates a comprehensive transformation in talent cultivation but also elevates the quality of education in Supply Chain Management courses. The introduction of industry collaborations as educational projects enhances the relevance and innovativeness of case studies, enriching the learning experience. Simultaneously, restructuring the curriculum and pedagogical approaches significantly enhances students' enthusiasm for learning and improves their overall academic performance. The teaching philosophy, rooted in the combination of CDIO and OBE, proves to be an effective framework, catering to the demands of a digitally driven and versatile workforce. This approach serves as a valuable guide in enhancing the quality of education and teaching in Supply Chain Management courses.

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