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Reform and Ideological Practice of Operations Research Course in Management and Engineering with The Integration of CDIO and PYTHON

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Abstract: It is pointed out in the National Education Conference and the National Conference on Ideological and Political Work in Colleges and Universities that colleges and universities should apply for ideological-political courses throughout the whole process of higher education, which provides incentives for deepening the reform and ideological-political practice of management engineering and operations research courses. Based on the integration of the CDIO teaching concept and Python and the immersive teaching process of the operations research course, this paper designs the teaching reform and practice of student-oriented management engineering and operations research course, which leads students to realize the algorithm design, program implementation, and visualization of operations research modeling and machine learning step by step. On this basis, based on the inventory management and its expansion model in operational research, taking grain supply chain management as the case object, this paper explores the strategic deployment of the CPC Central Committee and the state to realize the dynamic balance of grain supply and demand at a high level and deal with the uncertainty of the external environment with the security and stability of grain supply, from the perspective of variable cost, supply capacity, consumption demand, holding cost and shortage cost in the model. The research results are conducive to strengthening students' problem analysis and modeling ability, programming, and in-depth analysis, and have theoretical and practical value.

Keywords: Operation Research; Ideological-political Courses; CDIO Concept; Supply Chain Management.

1. Introduction

The National Education Conference and the National Conference on Ideological and Political Work in Colleges and Universities have pointed out the direction for the cultivation of talents in colleges and universities in the new era, pointing out that the foundation of colleges and universities lies in the cultivation of morality and the development of people, and that the ideological and political work should be carried out throughout the whole process of teaching and learning in higher education[1]. The Guideline for the Construction of Ideological and Political Work in Higher Education Courses issued by the Ministry of Education points out that it is necessary to comprehensively promote the construction of ideological and political work in higher education courses, emphasizing that the ideological and political resources in all kinds of courses should be fully explored and the nurturing role of each course should be brought into play, so as to comprehensively improve the quality of talent cultivation[2]. In recent years, with the strengthening of resource and environmental constraints on the development of society and economy, the discipline of management science and engineering has become more and more important in the management discipline, which requires management and engineering students to have the ability to comprehensively use system science, management, mathematics, economics and behavioral science and information technology to study and solve social, economic and engineering problems involving resource optimization, uncertainty decision-making, and project management[3]. Operations research, as a comprehensive integration to enhance the ability, aims to achieve optimal allocation of resources in economic systems, where the theories of linear programming, transportation problems, dynamic programming, integer programming, graphs and networks, storage theory, queuing theory, large-scale discrete solving, and nonlinear optimization all provide rigorous solutions for economics and management [4-5]. However, there are many problems in the actual teaching process of operations research courses [6]. For example, students lack the ability to interpret the actual needs and program implementation, the teaching content ignores the principle of algorithm design peeps and the use of modern intelligent solving tools or software, the lecture-based teaching method and complex knowledge system constrains the enthusiasm of students to participate in the course. These real-life problems constrain students' independent learning and practical innovation and urgently require systematic curriculum reform.

Recently, the CDIO teaching concept, a successful model of international engineering education reform initiated by MIT and four other highly efficient institutes, has attracted the attention of educators at home and abroad for its ability to enable students to learn more actively and efficiently and realize multi-faceted development[7].CDIO teaching concept stands for Conceive, Design, Implement and Operate, which is based on the four levels of product development to product operation life cycle, The concept of CDIO teaching stands for Conceive, Design, Implement and Operate, which takes life cycle from product development to product operation as the carrier, and the cultivation syllabus starts from the four levels of engineering basic knowledge, personal ability, interpersonal team ability and engineering system ability so that the students can construct the knowledge system more solidly and utilize it flexibly in practice[8]. So far, more than 100 universities in China have joined the "CDIO Engineering Education Alliance." The teaching concept of this model is

committed to the common progress of students and teachers, and the students trained are welcomed by society and enterprises[9]. In the current context of artificial intelligence-led education reform, the deep integration of CDIO teaching concepts and artificial intelligence can help promote teaching reform, and the curriculum teaching under this integration realizes the dynamic interaction between students and teachers, and the teachers' teaching and homework design based on the learning situation builds an adaptive learning environment for the students[10]. Compared with traditional subject teaching knowledge, the main components of subject teaching knowledge integrating CDIO teaching concepts and AI expand from teacher's teaching and student's learning to the combination of teacher-guided and student-autonomous learning, the constituent dimensions move from a single cognitive dimension to a multidimensional focus on cognition, emotion, and morality, as well as the level of development moves from lower-order cognitive development of the students to the higher-order unity development of the teaching and educating people [11].

In light of this, this paper takes the integration of the CDIO teaching concept and PYTHON language as the entry point, based on the immersive whole-process teaching process of "case-problem-modeling-programming-data import-result visualization-sensitivity analysis-interpretation problem," leading students to realize linear planning, dynamic planning, operations research in management engineering courses one by one. Based on the immersive teaching process of "case-problem-modeling-programming-data import-visualization of results-sensitivity analysis-interpretation of problems," this paper designs a student-oriented reform and practice of the teaching of operations research courses in the management and engineering fields and leads the students to realize the problems of linear programming, dynamic programming, transportation problems, integer programming, shortest-circuit problems, graphs and networks, storage theory, queuing theory, nonlinear programming, and machine learning one by one, nonlinear planning, machine learning, and other models of algorithm design, program implementation, and visualization. On this basis, we explore the students' adaptive learning and innovation ability to link theory to practice in the context of the Made in China 2025 strategy, the goal of peak carbon and carbon neutrality, and the resource allocation and environmental constraints under the new development pattern of double-cycle. The curriculum reform in this paper combines the applied research of management science and engineering disciplines, and the research results are conducive to strengthening students' abilities in problem analysis and modeling, program writing and in-depth analysis, etc. The research results have both theoretical and practical values.

2. Reform System of Operations Research Course

Based on the goal of cultivating students' adaptive learning of operations research course and practical innovation ability to real problems, this paper designs the reform system of operations research course from two perspectives of teaching content and course ideology and politics, and the logical system of course reform is shown in **Figure 1**.

2.1. Reform of the Operations Research Curriculum through the Integration of CDIO and PYTHON

Unify the content of the operations research course in the "conception," "design," "realization," and "operation" of the CDIO teaching concept. CDIO teaching concept relies on PYTHON programming language and artificial intelligence algorithms to realize the integration of knowledge and ability cultivation.

(1). Reform and practice of course content of conceptualization ability

Give a general overview of the course content of Operations Research to determine the basic conceptual needs and theoretical system of the course. Students are required to form the knowledge system of operations research independently before the start of the course, and when the course starts, it is introduced through the real-life case of Civics so that students can conceptualize, communicate as well as complement each other independently; complete the construction and analysis of the problem under the guidance of the teacher, and lay the foundation for the subsequent design, realization, and operation.

(2). Curriculum content reform and practice of design competence.

Clarify the core problems, optimization goals, and resource constraints in the case of Civics and Politics, guide the students to formulate a plan in the form of a team, especially the construction of the model and the design of the idea, require the students in each team to put forward the design, and then the team will learn from each other and compare with each other, deepen the students' analytical ability of the problem-solving process and the ability to expand their thinking through full interaction and discussion.

(3). Reform and Practice of Curriculum Content for Realization Ability

Aiming at the phenomenon that students lack the ability to solve large-scale problems, the reform of this paper focuses on the introduction of PYTHON programming language into the teaching of program implementation of optimization problems in operations research, which in turn improves the cultivation of the ability to solve practical problems. Students are required to participate deeply in the immersive process of "case - problem - modeling - programming - data import - result visualization - sensitivity analysis - problem interpretation." To enhance students' proficiency in using PYTHON and their ability to solve practical problems so that students are no longer confined to the analysis and calculation of low-dimensional examples, to stimulate students' continuous innovation and self-improvement, and to encourage students to comprehensively utilize the knowledge related to operations research and artificial intelligence algorithms to conduct course design, mathematical modeling competitions, and scientific research.

(4). Course Content Reform and Practice of Operational Competence

The course requires each student to self-nominate and report on scientific research papers or innovative projects, explore their relevant principles and ideas, innovative points and problems, teacher evaluation and research reports are included in the assessment, forming a diversified assessment system, leading students to deeply understand and learn about the relevant fields and cutting-edge hot topics, and to form their own thinking insights.

Table 1. Core PYTHON commands for solving operations research knowledge

• from scipy import linalg as la • from scipy import optimize • import sympy • import numpy as np	• import matplotlib.pyplot as plt • from cvxopt import matrix, solvers • import networkx as nx • from queue import Queue

knowledge module	PYTHON code	knowledge module	PYTHON code
LP	• sol = solvers.lp(c,A,b) • x_sym_sol = A.solve(b)\ • x_num_sol = lambda p: np. linalg. solve(AA(p), bb) • sol, r, rank, sv = linalg. Lstsq (A.T, Y)	NLP	• r_min = optimize.brent(f, brack=(xmin, xmax)) • sols = optimize.minimize_scalar(f, bracket=(xmin, xmax)) • x_opt = optimize.fmin_ncg(f, (x, y), fprime=fprime, fhess=fhess) • x_opt = optimize.fmin_bfgs(f, (x, y), fprime=fprime) • x_opt = optimize.fmin_cg(f, (x, y), fprime=fprime) • x_opt = optimize.minimize(f, [x, y], method='L-BFGS-B').x • x_cons_opt = optimize.minimize(f, [x, y], method='L-BFGS-B', bounds=[bnd_x1, bnd_x2]).x • x_cons_opt = optimize.minimize(f, (x, y), method='SLSQP', constraints=constraints).x
Shortest Path Problems	• Class Graph(): • def Dijkstra(self, src): • def bellmanFord(self, src): • def solveFloyd(self): • def aStar(self, start, end):		
Figure And Network	• G = nx.Graph() • G = nx.DiGraph() • G = nx.MultiGraph() • G = nx.MultiDiGraph() • def maxAreaOfSland(grid): • def DFS (x, y, grid): • def _init_(self, row, col):		
Dynamic Planning	• def goldMan(n, m, g, L) • def goUpStairs(n): • def backpack_record(n, c, w, v): • def getdp(arr): • def generateLIS(arr)	Machine Learning	• def gaussMixture(x y, N) • def ID3classify(T, test) • def C45classify(T, test) • def CARTclassify(T, test) • def BPAlgorithm(x, y) • def ada_boost_train(x, y, iters=N) • def random_forest_train(x, y, iters=N)

2.2. Reform and Practice of the Ideology and Politics in the Teaching Content of the Operations Research Course

Based on the strategy of "Made in China 2025", the "3060 dual-carbon" goal of peak carbon attainment and carbon neutrality, as well as resource allocation and environmental constraints under the new development pattern of the double-cycle, we will formulate the reform of course ideology and politics and practice of the content of the operations research course.

(1). The practice of course ideology and politics of cultural self-confidence

Explaining the development history of operations research in China, analyzing the new demands for resource allocation and environmental constraints under the new development pattern of double-cycle, analyzing the theory of Made in China 2025, the two mountains, and the new development pattern of double-cycle, understanding the wisdom of operations research and cultural inheritance in China, and grasping the background of the national strategic planning, so as to cultivate the students' cultural self-confidence and the spirit of exploring without fear of difficulties.

(2). Curriculum Civic Practice of Theoretical Confidence

Taking the development history of Beidou satellite and national strategic needs as elements of ideological and political education, we carry out discussions on the dialectical relationship between local optimization and global integration, interpret the superiority of the socialist system, and at the same time, excavate the degree of difficulty and complexity in realizing the global optimization, so as to stimulate the students' feelings of patriotism and firm confidence in the road.

(3). The practice of institutional self-confidence in the course of ideology and politics

In-depth analysis of the new development pattern of double-cycle and consumer preference, the theory of two mountains and carbon policy, aiming at understanding the policy background of expanding domestic demand in the current environment, supplemented by the domestic and foreign cycles, understanding the deeper meaning of the green mountain and green water is the golden mountain, grasping the degree of impact of carbon constraint policy on the manufacturing supply chain and the innovation path of the manufacturing enterprises, and fostering the students' ability to link theories to practice.

(4). Curriculum Civics Practice of Socialist Core Values

Interpret the ideological and political education elements of the three-step strategy of Made in China 2025, the demand for scientific and technological innovation talents and resource and environmental constraints in the context of RCEP, understand the three-step strategy of Made in China and the Regional Comprehensive Economic Partnership Agreements, identify the constraints and resource allocation for the realization of China's key chokepoint technologies, and stimulate students' patriotic sentiments and socialist core

values.

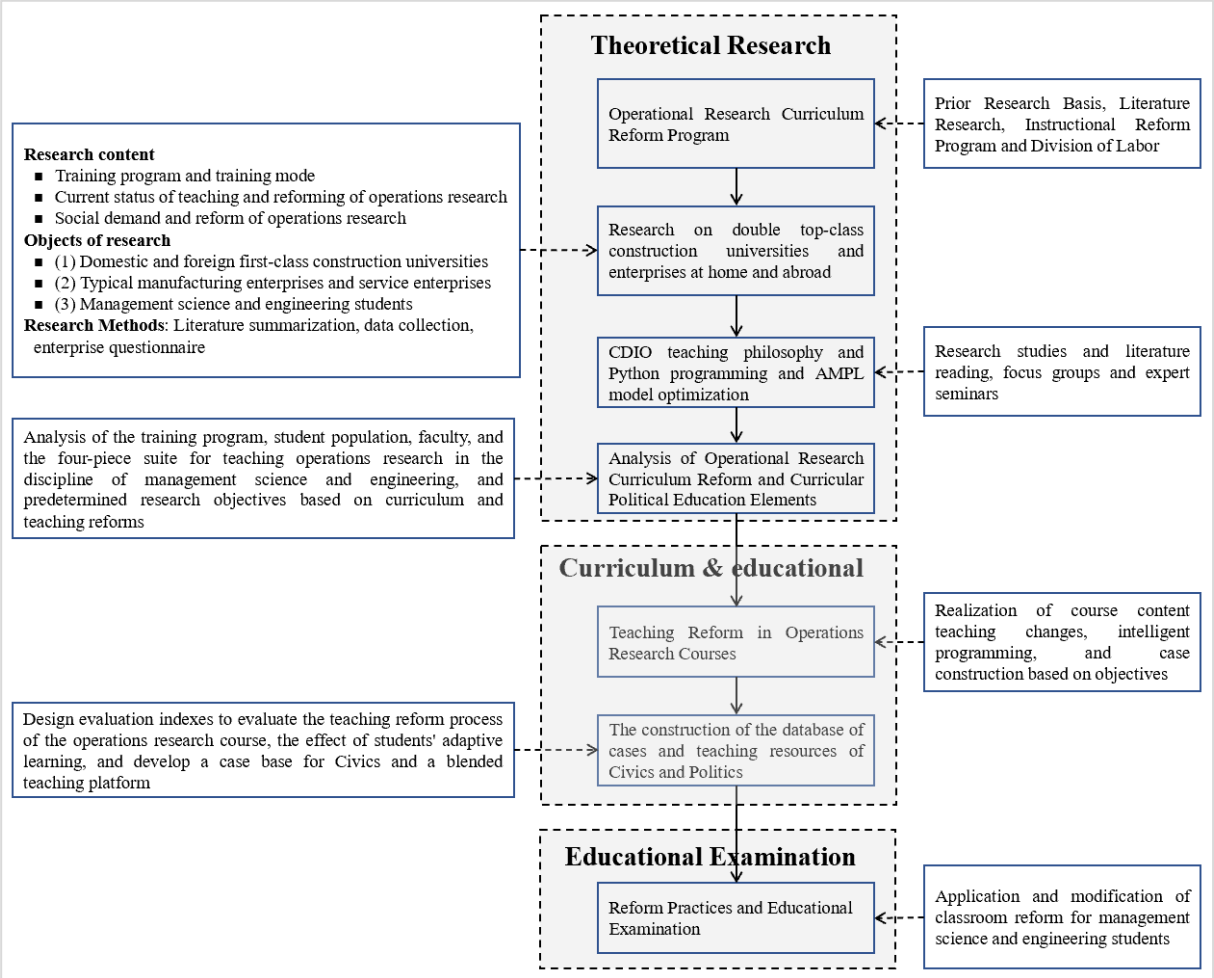


Figure 1. CDIO and PYTHON fusion of management and engineering operations research course reform system

3. Practice Case of Operations Research Curriculum Reform in Food Supply Chain Management

The people are the foundation of the country, and grain is the life of the people. Grain is a basic and strategic industry related to the national economy and people's livelihood, and it is the foundation for building a community of human destiny. Xi Jinping has repeatedly emphasized that solving the problem of food is always the top priority of national governance and has put forward a series of strategic ideas and decision-making deployments, such as "food is the most important of all things."

In recent years, natural disasters, regional situations, economic shocks, new crown epidemic, and other unfavorable factors, domestic and international food production and marketing imbalance, and price volatility have risen as a matter of China's economy, society, and even the country's strategic security issues, the need for systematic theoretical research and practical exploration. As the Global Food Crisis Report (2021) points out, the global food problem has become a worrying trend since 2017. in 2020, 55 countries/regions around the world have food supply crises at IPC/CH level 3 and above, and the affected population has increased by about 20 million people compared to 2019, reaching 155 million people. The UN Secretary-General has called for "we need to reform the food production and marketing network system to make it more inclusive, flexible and sustainable," which is also one of the goals of the UN blueprint for the 2030 Agenda for Sustainable Development.

China is a major producer of grain, with total output stabilized at more than 650 million tons for many years, and is basically able to coordinate the nation's grain consumption needs under a system of guaranteed domestic supply supplemented by imports. However, it is also noted that China's regional food production and marketing imbalance phenomenon is also very prominent, with the rapid development of economic and social and urbanization, "two lakes, two broad," "Jiangnan fish and rice country," "Shu Tian Fu country With the rapid development of economy, society, and urbanization, the contribution of traditional grain-producing areas such as "two lakes and two provinces," "the fish and rice country in Jiangnan" and "the Tianfu country in Shudi" has been declining year by year, and the three northeastern provinces have become the largest grain-producing areas and grain exporting areas in the country, while the southeastern coastal provinces have become the largest grain-selling areas and inflow areas. Costs arising from the regional imbalance between food supply and demand affect the total operating costs of the food supply chain.

4. Conclusion

This paper integrates the CDIO teaching concept and PYTHON programming language to explore the teaching

reform of operations research course in management and engineering, based on the immersive whole-process teaching process of "case-problem-modeling-programming-data capture-visualization-sensitivity-interpretation problem." Based on the immersive whole-process teaching process of "case - problem - modeling - programming - data capturing - visualization - sensitivity - interpretation of the problem," this paper designs a student-oriented teaching system for operations research courses and analyzes the operations research problems and model construction based on the Civic and Political Affairs cases, which helps students to identify the real problems in economic management based on the mastery of system boundaries, sensitivity analysis, ease of handling, and validity of the modeling in operations research, and helps students to identify the real problems in economic management. In addition, it helps students to identify the deterministic and stochastic mathematical models in economic management, numerical search, exact solutions, and heuristic solutions in operations research.

The research in this paper is conducive to enhancing students' motivation to implement different operations research problems in their own programs, improving their proficiency in the use of intelligent languages and smart algorithms such as PYTHON and AMPL, and enhancing the design of algorithms and implementation of programs for solving models such as linear programming, dynamic programming, transportation problems, integer programming, assignment problems, shortest-circuit problems, graphs and networks, storage theory, queuing theory, and nonlinear programming, and so on. It solves the plague of traditional operations research teaching being lecture-based and the complex knowledge system constraining students from solving real-world problems.

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