

## OBE-CDIO Reform of Operations Research for Engineering Education

Li Nie<sup>1</sup>, Xiaoyan Wu<sup>1\*</sup>, Xiaogang Wang<sup>1</sup>, Fenfang Zeng<sup>2</sup>

<sup>1</sup>College of intelligent manufacturing and control engineering, Shanghai Polytechnic University, Shanghai, China

<sup>2</sup>Wuhan KAIMU Information Technology Co., Ltd, Wuhan, China

xywu@sspu.edu.cn

**Abstract.** According to the particular requirements of engineering education in colleges and universities, the paper integrated OBE and CDIO education concepts and carried out reform on the teaching concepts, teaching contents, and teaching methods of operations research to solve the outstanding teaching problems of the courses.

**Keywords:** Operations Research; teaching reform; OBE; CDIO.

### 1. Introduction

The development of the new economy has put forward high requirements for high-level innovative talents with the intersection of industry and management. The industrial chain of the new economy has broken the specialized division of labor of traditional disciplines, making the concept of talent training in China's higher education gradually change from the narrow sense of talent concept that only paid attention to individual quality in the past to the broad sense of talent concept that paid more attention to talent cooperation and communication, innovation and decision-making ability [1]. Operations research is a comprehensive course that takes man-machine systems as the organization and management means, and takes mathematics and computer as tools to study the rational planning and optimal decision-making scheme of various limited resources. Operations research is a fundamental professional course with strong practicality and applicability. It occupies an essential position in the management discipline and modern management methods. Its theories and methods play an important role in scientific management, information management, engineering technology, social economy, military field, and social decision-making, and have produced substantial economic benefits. As one of the core courses for the cultivation of industrial engineering undergraduates, the operations research course is an important carrier of their innovative thinking. It is imperative to reform the teaching concept, teaching mode, and teaching method of the course in the new talent requirement [2].

There are many problems in the practical teaching process of operational research, especially in ordinary colleges and universities characterized by engineering education. For example, teachers usually focus on the analysis of the theory knowledge of various case models, but ignores the refinement and analysis of practical application of the models; Teachers usually focus on the calculation process, but ignores the principle of algorithm design and the use of solution tool software; The complexity of knowledge system and the difficulty of learning affect students' enthusiasm and interest; Most of the teaching methods are mainly teaching, and the students' active learning ability is poor. With the continuous change in talent requirements and the continuous development of higher education, this traditional teaching model has been challenging to meet the new talent requirements. With the high-level development of quality education to intelligent education, it is a trend under the new situation to integrate OBE and CDIO education concepts into the curriculum teaching reform of engineering education universities in China.

OBE (outcome-based education, OBE) was first proposed by B. Spady in 1981. OBE research results point out that based on students' learning results and efficiency, the results are obtained through inquiry and analysis according to professional characteristics and work attributes, and the results-oriented education is constructed and composed of the structural theory of this professional achievement itself [3]. OBE has been widely used in engineering education talent training, education and teaching reform, and specialty construction in Colleges and universities in recent years. CDIO

(stand for conception, design, implementation, and operation, CDIO) Engineering education mode is the latest international engineering education reform achievement in recent years [4]. Its teaching framework reflects innovative educational ideas and encourages students to learn in an active theory linked to practice, mutual integration, and organic connection between courses. Taking the teaching reform of "operations research" course for industrial engineering undergraduates as an example, we discuss how to introduce OBE and CDIO into the teaching process of operations research, and do some rational reform practice in teaching ideas, teaching methods, teaching plan design, etc.

## **2. Reform measures**

### **2.1 Renewal of Teachers' Teaching Ideas**

In order to understand OBE and CDIO teaching concepts and realize that practical ability is also an essential basic ability of students, many relevant teachers are regularly organized to participate in seminars to strengthen communication, unify ideas and improve understanding. Meanwhile, they exchange and study with other colleges and universities that carry out OBE and CDIO pilot projects from time to time.

### **2.2 Design of Training Objectives and Contents**

In order to incorporate OBE and CDIO education concepts in the teaching of operations research, we revised the training plan and reconstructed the teaching system. The teaching system includes theoretical teaching, experimental teaching, and quality development. It reflects the cultivation of students' basic knowledge, personal ability, interpersonal team ability, and engineering system ability, and achieves the goal of cultivating students' creative practical ability to solve practical problems under the new economic background by using the "operations research" theory. Specifically reflected in:

The course of Operations research generally includes some classical contents such as linear programming, nonlinear programming, integer programming, objective programming, dynamic programming, graph theory and network, queuing theory, storage theory, game theory, multi-objective decision-making, etc. However, there are many teaching contents, while the class hours are limited, and the specific needs of different universities and the abilities of students of different majors are different. Therefore, it is necessary to select the teaching contents according to the requirements and abilities. Considering that ordinary college and university students are generally poor in study abilities, combined with the special needs of industrial engineering majors, we chose some basic contents, such as linear programming, integer programming, dynamic programming, graph theory and network, etc. We set the teaching objectives as the application and solution of the basic model, weakening the theoretical derivation and analysis in order to help students to master the ideological method of "operations research" and its model structure, and emphasizing the cultivation of students' ability to model practical problems and quickly solve them with the help of computer software.

In order to guide students to achieve the purpose of ability training and comprehensive development, we helped students establish a link between the teaching content and practical application through guiding cases and the latest application of operations research knowledge in manufacturing and other fields. For example, after completing the linear programming model and its sensitivity analysis, we have added a practice program to train students' ability to build models according to actual application scenarios such as marketing, finance, production management, revenue, etc.

Since operations research has always been considered one of the most challenging courses for students, we also helped students raise their interest in operational research by connecting real life with practical activities. We designed some practical projects related to real-life to run through the whole process of operations research learning so that students can experience the application and problem-solving process of operations research while learning theoretical knowledge to form a benign interaction between the learning and application of knowledge. For example, we designed a

practical project to prepare for the graduation ceremony by group, allowing students to find information by themselves and formulate a practical graduation ceremony plan for the graduation class to ensure a certain cost and efficiency. In this way, their practical activities are closely related to their lives so that their interest in operations research increases gradually.

### **2.3 Preparation of Teaching Materials**

We have built a wealth of "three-dimensional" curriculum resources, including courseware, lesson plans, problem sets, case bases, practice instruction manuals, video teaching, etc. Through the network cloud platform, we have realized the sharing of curriculum resources and met students' personalized learning needs. We focused on the courseware and video of the courses taught by our teachers, and introduced the existing online courses of operations research on the superstar platform as a supplement; We divided the syllabus into small knowledge points, and allocated appropriate exercises and homework topics according to the knowledge points; According to students' different understanding and operating abilities, we provided students with different levels of curriculum learning resources and practical resources, and made corresponding evaluations, which not only meet students' personalized learning needs, but also urge students to improve their learning enthusiasm; Based on students' cognitive model, we dynamically updated a series of teaching resources from time to time according to the frontier dynamics of the discipline and the needs of social development.

### **2.4 Mixure of Online and Offline Teaching**

In order to make full use of the electronic course resources constructed and the existing national excellent course resources in other colleges and universities, we have designed an online and offline hybrid teaching mode, which includes explicitly three parts: before class, during class, and after class.

The pre-class preview program includes students watching videos of knowledge points online according to their learning objectives.

The in-class teaching plan includes the teacher's lecture, checking the students' preview to explain the key points, difficulties, and doubts, answering the students' questions, and summarizing the course.

The after-school review plan includes students' sorting out the knowledge points in the classroom, reviewing the knowledge points through online courses, consolidating the knowledge in time through online tests, and consulting the teacher through the online course platform in case of any problems.

### **2.5 Mixure of Inquiry and Practical Teaching**

In order to embody OBE and CDIO in teaching practice, the method of combining inquiry classroom teaching with practical teaching was adopted. The class is student-centered, and teachers should guide students to learn actively. In the teaching process, we usually raise questions to guide students to think, discuss, and increase active learning and hands-on practice to cultivate students' abilities to analyze and solve problems; because of the current students' lack of practical ability, we arranged rich design work and comprehensive experiments, and tried to let students do it by themselves and devote themselves to it; In the experimental class, on the one hand, students were encouraged to experience the significance of teamwork and mutual trust and assistance. On the other hand, after the experiment was frustrating, students were inspired by teachers to analyze their causes of failure to discover new principles and knowledge and cultivate students' ability of systematic thinking and knowledge discovery.

## **3. Effect of reform**

Under the concept of OBE and CDIO, a series of reforms have been carried out for the operations research course, and the following achievements have been achieved:

Students' interest in learning has been stimulated, and their enthusiasm for active participation has been improved. After introducing OBE and CDIO teaching concepts, the attendance rate of students has been greatly enhanced. Due to the preparation before class, most students come to the class with

questions and pay much more attention than before. Students' innovation ability has also been enhanced. Under the guidance of teachers, many students will use their spare time to enrich their knowledge, and the number of students participating in innovation competitions inside and outside the school has increased.

Students' course performance has improved. In addition, students' plagiarism of homework was significantly reduced, learning and communication increased, and their team cooperation ability was exercised.

Increased efforts to train talents. Taking cases as the carrier to organize teaching makes students' learning process full of challenges and practicality, which is also very helpful for future work.

The improvement of teachers' ability. The constantly updated cases and discussed in class will encourage teachers to continually enrich their academic knowledge, explore better teaching methods, further achieve scientific research results in related fields, and improve their personal ability and thesis level.

#### **4. Acknowledgment**

This project is funded by Local high-level construction projects and the State Key Research and Development Program of China (2019YFB1704302).

#### **References**

- [1] J. Zheng, Y. Ding, G. Ma, Y. Liu, "Discussion on the reform of operational research teaching mode," *College education*, 2014, pp. 73-74.
- [2] S. Duan, L. Li, L. Feng, M. Ren, "Curriculum Hybrid Teaching Reform Based on cdio-obe concept - Taking management operations research as an example," *Modern vocational education*, 2021, pp. 20-21.
- [3] W. Liu, G. Wang, L. Wang, "Teaching reform of management operations research course for logistics management specialty based on OBE concept," *Logistics Technology*, vol. 44, 2021, pp. 170-172.
- [4] G. Liao, "Teaching reform of operations research-based on CDIO mode," *Intelligence*, 2015, pp. 169