

## RESEARCH AND PRACTICE OF MATHEMATICAL MODELLING COURSE BASED ON OBE-CDIO TEACHING CONCEPT

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### **ABSTRACT**

*Combined with CDIO Engineering Education, OBE teaching concept is introduced into the teaching of mathematical modelling course to carry out teaching reform research. According to the OBE concept, the curriculum learning results are set and the project is designed. And under the guidance of CDIO standard, the curriculum is implemented according to the engineering education concept. The OBE-CDIO teaching mode is proposed to explore a new teaching mode of mathematical modelling course and improve the teaching effect. The results show that OBE-CDIO teaching mode can stimulate students' subjective initiative to explore, discover and construct knowledge in learning mathematical modelling, and provide reference for improving teaching quality.*

**KEYWORDS:** *OBE-CDIO; Mathematical Modelling; Teaching Reform; Teaching Evaluation*

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### **INTRODUCTION**

In the past half century, with the rapid development of computer technology, the application of mathematics not only plays an increasingly important role in engineering technology, natural science and other fields, but also penetrates into new fields such as economy, management, finance, biology, medicine, environment, land quality, population, transportation and so on with unprecedented breadth and depth. Mathematical modelling is the main way to integrate mathematical science with practice, which is one of the ways to improve the use of mathematical knowledge to solve practical problems, basic skills, cultivate and train comprehensive ability of a new discipline. Mathematical Modelling course appeared in American universities as early as 1960s [1]. In the early 1980s, the course of mathematical modelling entered China. With the construction and development of more than 40 years, it has become the most common mathematics course in Colleges and universities besides advanced mathematics and linear algebra.

Mathematical modelling is a process of solving complicated practical problems simply and abstractly into a reasonable mathematical structure. It is a necessary way to solve all kinds of practical problems by applying mathematics. It is one of the important abilities of modern professionals, especially "excellent engineers". With the reform and deepening of the curriculum system, the traditional teaching methods cannot meet the training requirements for undergraduates. Therefore, we need to take some measures in teaching content, teaching methods and means to improve the traditional teaching mode.

Outcome Based Education (OBE) is one of the hot issues in the current higher education research [2]. It is an educational concept based on students' learning outcomes. It holds that the goal of teaching design and teaching implementation is the learning outcomes achieved by students through the education process. Stressing on student outcomes, OBE is a natural progression in the development of higher education with the focus on more effective teaching and learning at course and programming levels. The key of OBE is the expected learning effect of the course, and the training objectives and graduation requirements are pushed back to the curriculum objectives of mathematical modelling course. Therefore, it is very meaningful to reconstruct the teaching module of the course.

CDIO is a framework that provides students with an education stressing engineering fundamentals set in the context of Conceiving-Designing-Implementing-Operating real-world systems and products [3]. CDIO training syllabus divides the ability of engineering graduates into four levels: basic engineering knowledge, personal ability, interpersonal team ability and engineering system ability. The syllabus requires comprehensive training methods to enable students to achieve the predetermined goals in these four levels. OBE and CDIO training mode is basically consistent with the concept of applied talents training in China, and systematically reflects the concept of "combination of learning and doing". Therefore, this paper proposes to use OBE-CDIO engineering education mode to design and develop the teaching of mathematical modelling course, which provides a new teaching reform idea for improving the teaching of this course.

## **OBE AND CDIO EDUCATION CONCEPT**

OBE refers to the education mode based on learning output, focusing on the engineering education concept of "student-centred, achievement oriented and continuous improvement". Since the 1980s, the 1 education model based on learner-centred and learning outcomes has been widely popular in the western educational field. OBE originated from the reform of basic education in the West. American scholar William G. Spady made an in-depth study of OBE model in his book "Outcome-Based Education: Critical Issues and Answers" [4]. OBE education concept is closely related to scientific frontier, engineering practice and social application practice, aiming to make curriculum design and teaching objectives meet the needs of the industry [5]. OBE education concept takes students' learning outcomes as the guidance, reversely determines the teaching plan and teaching links, takes students as the teaching centre, and teachers guide students to achieve the expected learning objectives. American Engineering Education Accreditation Association has fully accepted the OBE education concept and put it into the engineering education accreditation standards. Considering the national industry needs and relying on engineering projects, many colleges and universities build a comprehensive applicative talents system based on OBE.

CDIO stands for the engineering education mode of conception, design, implementation and operation. It is an organic combination of "project-based teaching" and "hands-on learning" [6-7]. The idea of CDIO not only inherits and develops the idea of engineering education reform in Europe and the United States for more than 20 years, but also systematically puts forward 12 operable standards of ability training, comprehensive implementation, inspection and evaluation. CDIO embodies the unity of systematization, science and advanced character, representing the development trend of contemporary engineering education.

Combined with the national education policy of applied talents training, on the basis of OBE, CDIO practice teaching mode is integrated. In the teaching process, the introduction of engineering application education, emphasizing the project as the carrier of learning courses, mastering the teaching mode of practical application as the goal, analysing and practicing the projects in the teaching process, so as to combine the theoretical knowledge and practical application of

students, so as to improve their engineering application ability. Cultivate new engineering talents with solid professional knowledge, good engineering practice ability, project management ability, team cooperation ability, innovation ability, social responsibility and professional ethics.

Based on OBE and integrating CDIO, engineering application education is introduced into the teaching process, which emphasizes the project as the carrier of learning course, grasps the teaching mode of practical application as the goal, analyses and practices the projects in the teaching process, so as to combine the theoretical knowledge and practical application of students' learning to improve their engineering application ability [8]. Cultivate new engineering talents with solid professional knowledge, good engineering practice ability, project management ability, team cooperation ability, innovation ability, social responsibility and professional ethics.

## **OBE-CDIO TEACHING IMPLEMENTATION**

Reference from the OBE engineering education concept, teachers determine the teaching objectives and formulate the teaching process, so that students can deepen their understanding of these knowledge through the conception, design, implementation and operation of the project. In the teaching practice, through the organization of discussion, stimulate students' interest, increase their perceptual knowledge, and improve their ability of analysis, induction and summary. OBE and CDIO teaching mode can not only enable students to acquire basic theoretical knowledge, but also enable them to contact with engineering practice earlier in the process of using knowledge to solve problems, and cultivate their practical interest and practical ability.

### **Course Objectives**

Establishing teaching objectives is the first step of OBE teaching, the key to designing teaching activities, and the premise to ensure students to achieve the expected learning objectives in teaching activities. Teaching objectives should be guided by the needs of the industry, and curriculum teaching should be guided by teaching objectives, and teaching resource allocation should be guided by supporting the outcomes of teaching objectives.

Mathematical modelling teaching based on OBE takes the mastery of theoretical knowledge and the improvement of practical ability as the teaching goal, and emphasizes the equal emphasis of knowledge and ability. Integrating the CDIO practice teaching mode, the project-based teaching activities are carried out from the aspects of conception, design, implementation and operation, focusing on the ability of students to use new knowledge and technology, and integrating the teaching of traditional basic concepts, important principles and basic theories into the course of mathematical modelling, that is, learning and teaching based on project. The specific four objectives of OBE-CDIO mathematical modelling course are listed as follows.

Teaching objective 1: master the basic ideas, methods and skills of mathematical modelling, can use standard mathematical language to describe practical problems, establish mathematical models, design algorithms, analyse and solve some simplified practical problems.

Teaching objective 2: cultivate students' innovative consciousness, be able to use the theories, methods and skills, establish mathematical models, use computers and mathematical software to solve more complex practical problems, so as to improve students' mathematical quality and comprehensive ability.

Teaching objective 3: to cultivate students' ability to solve practical problems by applying mathematics and modern tools, and have basic research ability of scientific calculation and software development, such as analysis, induction, data processing, modelling, software design and development, etc.

Teaching objective 4: Master self-study ability and communication ability, have strong organizational ability and team spirit. Be able to divide and cooperate in the team, use the mathematical modelling knowledge to solve more complex practical problems, and write curriculum papers.

### **Teaching Design**

Reverse instructional design is the second step of OBE teaching. Paying attention to students' learning outcomes is the core of teachers' organization teaching. Therefore, we should reverse design the teaching contents from the results of learning. The success or failure of teaching depends on whether students get the learning results or whether they can acquire practical abilities. Innovate teaching mode and reform teaching method. Break the traditional classroom silence, adopt flexible and diverse teaching methods, such as case teaching, flipped classroom, group discussion, etc., radiate the vitality of the classroom, so as to mobilize students' interest in learning, stimulate students' learning enthusiasm, and cultivate students' awareness of subject, problem, openness, training, interaction and communication[9].

The teaching process is task driven, supplemented by different teaching methods. On the basis of understanding and mastering the theoretical knowledge of mathematical modelling, the students will be able to complete the following steps: problem description and goal design, problem posing, problem analysis, problem hypothesis, variable description, model establishment, model solving, model checking, model correction, report writing and defence, to cultivate students' ability of modelling and solving complex practical problems and promote the achievement of curriculum objectives.

In the conception (C) stage, the inquiry teaching method is introduced to stimulate students' imagination and creativity, guide students to start from the research problems, according to the problem description, comprehensively use appropriate methods, retrieve the background knowledge of related problems, carry out problem description and goal design, and strengthen students' ability to analyse problems and determine the goal through report writing. In the design (D) stage, the split classroom teaching mode and inquiry teaching method are introduced to trigger students' curiosity about model building, guide students to deepen their understanding of mathematical modelling, and use the basic process of mathematical modelling to transform practical problems into mathematical problems by simplifying, assuming, quantifying and modelling problems, i.e. mathematical model. In the implementation (I) stage, the demonstration method and discussion method are used to solve different mathematical models and guide students to realize the result demonstration of the problem with the help of algorithm and computer programming. In the operation (O) stage, the inquiry teaching method and discussion method are introduced to guide students to develop the habit of exploration. The sensitivity, robustness, stability and other methods are used to test the model, and evaluate the effectiveness and feasibility of the mathematical model.

### **Teaching Evaluation**

The last step of OBE education mode is to establish an evaluation system to judge whether the students' outcomes in the whole teaching activities whether can achieve the expected learning objectives. Teachers evaluate students' learning outcomes through the evaluation system, so as to continuously improve the teaching process. The assessment and evaluation system should be objective and fair, in order to reasonably feedback students' learning effect, urge teachers to

improve teaching design, and promote the improvement of teaching quality. OBE education concept combines teachers' teaching, students' learning, project implementation, examination and other aspects organically. By adopting a diversified evaluation system, it ensures that the evaluation process runs through the teaching process of mathematical modelling course. As the assessment of learning effect, it should not only include the examination results, usual attendance and homework, but also include the performance of students' inquiry learning, experiment and practice in the learning process.

Through the records of the assessment process, students can be inspired to pay attention to learning results in the learning process of mathematical modelling course, and promote students to actively participate in the completion of the project. This kind of assessment method liberates students from the traditional examination mode of rote learning to cope with test papers, and constructs a new student-centred assessment mode. At the same time, it continuously optimizes the teaching process and innovates the teaching design of mathematical modelling through assessment analysis, which also meets the needs of the current application-oriented talent education.

The evaluation system is divided into four parts: pre class preview (10%), project report (40%), internship report (20%) and open project report (30%). Pre class preview is mainly aimed at the preview of four project reports, which requires students to understand the project background, be familiar with mathematical models and design solving algorithms; the project report score is composed of four parts According to the completion of the project report and the students' defense report, the assessment is made. Internship report requires students to write their experience and harvest according to the learning content; open project report requires students to establish models, build algorithms, solve models, analyse results and write reports according to the specified topics.

## CONCLUSIONS

OBE is a kind of educational idea which centres on learning results and organizes, implements and evaluates education. Based on CDIO, the curriculum practice project focuses on cultivating students' engineering and technical ability, especially the ability of project organization, design, development and implementation. OBE-CDIO teaching method helps to improve the teaching content of mathematical modelling, promote the realization of students' learning objectives, improve the course content on the basis of learning ability evaluation, and improve students' learning ability and innovation ability.

With the further application and practice of OBE-CDIO teaching mode, by optimizing the course content, design and assessment methods, the teaching quality and learning effect have been improved, which shows that the direction of curriculum reform is basically correct. We should continue to improve along this direction to further improve the teaching quality. CDIO engineering education concept and OBE education concept are effective guidelines to meet the requirements of society for engineering talents and improve the quality of engineering education.

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