Teaching Practice Research of *Electric Power System Analysis* Based on CDIO Mode

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Abstract. CDIO model is a kind of engineering education mode that aims to cultivate students' engineering application ability and effectively solve the employment problem. Taking *Electric Power System Analysis* as an example, this paper expounds the characteristics and implementation process of CDIO mode in the process of teaching, summarizes the role of CDIO model in engineering education, and improve the quality of double-ability teachers, create project implementation situation, plan teaching materials, innovative evaluation assessment system and other means to improve and perfect the implementation of CDIO mode in the course of teaching. After the teaching of the test and practice, it proved to have achieved good results.

Keywords: CDIO model · Engineering application ability
Power system analysis · Engineering education

1 Introduction

CDIO (Conceive Design Implement Operate) is an engineering education mode that has been explored and studied for four years by four universities such as Massachusetts Institute of Technology and Royal Swedish Institute of Technology in recent years, and has been internationally recognized and widely promoted [1]. CDIO mode refers to the teaching process, which based on the actual product and system concept-design-implementation-operation process, it takes the life cycle from product development to product operation as a carrier, comprehensive engineering basic knowledge, personal ability and teamwork ability to complete an educational activity. CDIO model is a kind of engineering education mode that aims to cultivate students' engineering application ability and effectively solve the employment problem. To date, dozens of world famous universities in France, Finland, Denmark, South Africa, Singapore and other countries have joined the CDIO model [2]. A typical representative of the Swedish National Agency for Higher Education (CDEC) used the CDIO model to evaluate its 100 engineering degree programs. The results show that it is more adaptable and more conducive to quality improvement, and especially important for the systematic

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development of engineering education. In engineering teaching, Mechanical Engineering Department and Aerospace Engineering Department have adopted CDIO model of engineering education concept and syllabus and have achieved good results. The students trained by CDIO model are greatly welcomed by society and enterprises. On January 8, 2016, the "National CDIO Engineering Education Alliance" was established in Shantou. The creation of the alliance brought the CDIO model under a new situation to a higher level, and gave the entire education community a high degree of recognition for the CDIO education model [3].

2 Research Background

In the application of skilled personnel training objectives, Electric Power System Analysis curriculum as a compulsory electrical courses, with strong engineering practice, it plays a role in the professional curriculum system [4]. Teaching plans and course positioning should meet the needs of future graduation and employment of students.

In recent years, teaching reform and practice, according to the *Electric Power System Analysis* the course features, but also try some teaching reform and achieved some results. However, due to the limitations of *theory of power system analysis*, such as strong theory, extensive contents, knowledge abstraction and large experimental facilities, the students 'learning difficulties are difficult to apply and unfavorable to the students' multi-level abilities, so that the traditional teaching of teaching knowledge and ability to cultivate out of touch, fail to achieve the desired teaching effect [5].

In the process of teaching, drawing on the integrated thought of CDIO mode can not only solve the problem of the lack of practical teaching equipment in *Electric Power System Analysis,* but also can realize the integration of theory and practice teaching, break the boundaries of theory and practice teaching, strengthen students 'vocational skills training and improve students' comprehensive ability.

2.1 Teaching Design

At present, the teaching method of *Electric Power System Analysis* is mainly based on the teaching method of combining the blackboard with PPT. Because of the abstract and esoteric theoretical knowledge, and the definition formulas involved are numerous, the computational derivation is complicated and the students are embarrassed or weariness [6]. In experimental teaching, the experimental equipments of the course are more expensive and more expensive, and students lack practical ability to practice. In addition, due to the complexity of the course supporting experiments, once a problem occurs, students and teachers spend a lot of time to solve equipment failure, So as to affect the progress of the experiment, which greatly weakened the enthusiasm of students to learn, resulting in poor experimental teaching. At the same time, due to the application of skilled personnel training, the theoretical class hours gradually

decreased, the teachers blind choice of teaching content, resulting in the textbook chapters are not in place, the ability to cover and depth of knowledge is not enough to reach the teaching effect.

2.2 "Double-Double Type" Faculty

"Double-teacher dual-type" teacher is the application of personnel training under the engineering specialty of teachers of the basic requirements. However, most full-time teachers from school to school, identity from students to teachers, the lack of business project experience and workplace technical specifications, good at theoretical knowledge of the "main" fear of project technology development and practical guidance, lead to the project teaching mission did not implement the concept of mission, the entire project because of negligence in management and in mere formality.

Through CDIO mode teaching, teachers should be further urged to participate frequently in social practice and in-depth enterprise research, maintain cooperation with enterprises, understand social needs, market trends, industry standards and technical specifications, and make preparations for the adjustment of personnel training programs. At the same time, it actively participates in the operation of enterprise projects and improves the ability and quality of practical operation. In practice, it grasps the distribution of project processes and their management, and develops them into technical or industrial engineers. It intensifies the combination of theory and practice and gives the students the latest industry concepts.

2.3 Textbook Selection

In recent years, *Electric Power System Analysis* courses are based on planning materials, increasing auxiliary materials, but these textbooks can only complete the concept of conceptual interpretation and verification of elaboration, the lack of application materials in accordance with the task demand model of the project can only rely on the teachers in the teaching aspects of the project tasks to build knowledge and training of knowledge and training students engineering thinking ability [7].

In order to better improve students' hands-on ability, most of the electrical engineering and automation students will serve the local power industry after graduation. According to the teaching concept of CDIO mode, we should take full account of the structure and trend calculation (including the simple trend and the complex trend) of the power grid when assigning the task items when selecting the teaching materials, combined with regional characteristics, textbooks focused on the actual state of the power grid system as an example, to achieve application-oriented undergraduate training objectives.

2.4 Evaluation System

The course of *Electric Power System Analysis* is a practical and practical curriculum. The focus of the course evaluation should include procedural evaluation, practical hands-on skills, ability to analyze and solve problems, reduce the difficulty of pure theoretical examination, truly theoretical and practical combination of engineering. However, due to the subjectivity of the teachers in the evaluation appraisal, the result of the appraisal is not entirely objective.

In order to reflect its objectivity and build a diversified evaluation system, the purpose of teaching evaluation is to give play to the role of guidance and motivation. According to the teaching concept of CDIO model, the evaluation system should focus on formative assessment and focus on the process of constructing knowledge and ability. The evaluation content is subdivided into four evaluation options: Concept (Proposal, Research and Analysis), Design (Diversity, Originality), Implementation (Progress Completion, Design Production), Operation (Entity Outcome, Research Report or Essay). The evaluation form adopts the principle that the comment and the scoring are combined. The evaluation subject introduces social evaluation (enterprise evaluation and expert evaluation) and student evaluation (self-evaluation and peer evaluation) based on the retention of teacher evaluation.

3 CDIO Model Features and Implementation

3.1 CDIO Mode Features

The purpose of CDIO model is to break the inherent logic and integrity of the knowledge structure of Power System Analysis [8]. Through the adjustment, optimization and reorganization of the curriculum content, CDIO mode can achieve the goal of training knowledge, ability and quality into engineering project carrier, emphasize the student easy to learn and easy to use, so that students have completed during the school simulation project “real experience”, which allows students to more employment and entrepreneurship capital, and make a new exploration for the teaching reform in the course of *Power System Analysis* in our college.

Guided by the concept of CDIO, the *Power System Analysis* course is based on the requirements of teaching reform of electrical automation major in our college [9]. Combining with the strong engineering features of this course, we give some lessons in the arrangement of design contents and pay attention to the use of engineering conclusions. The specific technical route shown in Fig. 1.

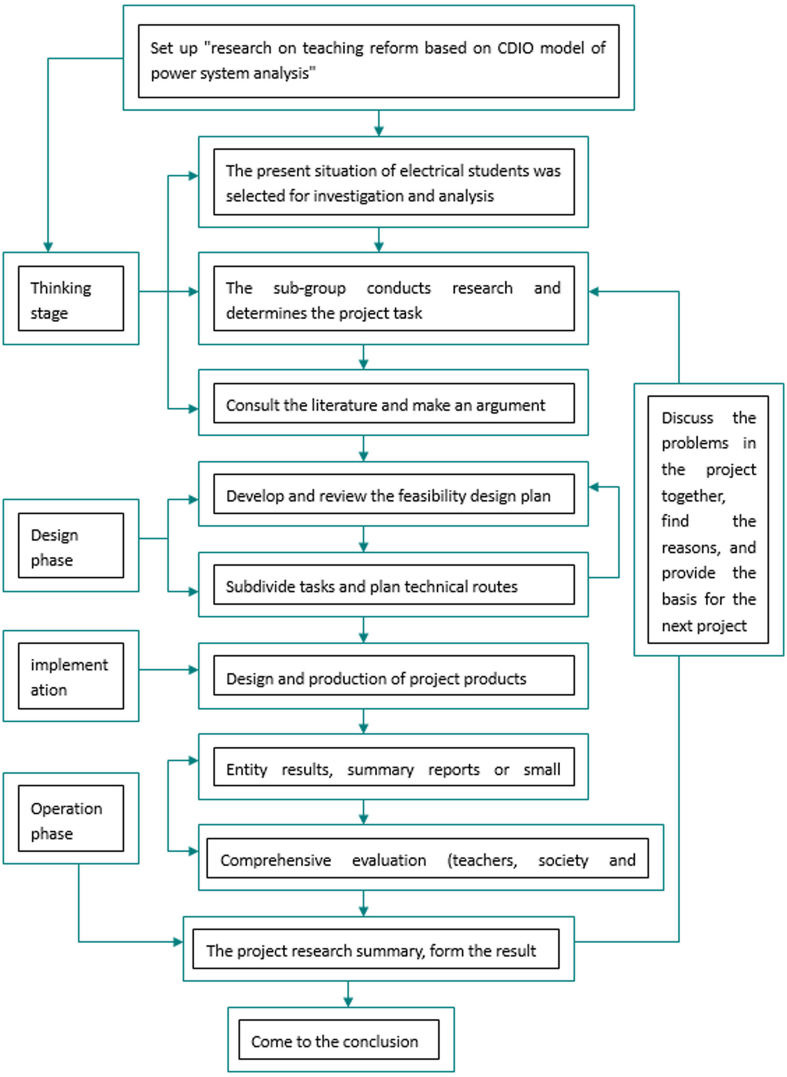

Fig. 1. "CDIO-based *Power System Analysis* course teaching reform" technology route

4 CDIO Model in the *Power System Analysis* Course Implementation

In the power system analysis course, the economic operation of the power system is the focus of this course, students are difficult to learn in depth and master [10]. In this teaching, according to the class of students for the 2016 class of electricity technology, arts and science students each account for 50% of the distribution of hydropower plants and thermal power plants between the day of active load economic optimization

process, according to the 2016 class for students of electricity technology class students, arts and science students each accounted for 50% of the distribution of hydropower plants and thermal power plants between the day of the active load economic optimization process, taking into account the characteristics of students grouped, actively organize the teaching content and teaching design of the *Power System Analysis* course and set up the concept, design, implementation and operation stages according to the concept of CDIO education. The specific operations are as follows:

(1) **Concept stage**

Power System Analysis course is mainly to train students to establish the concept of preliminary engineering, improve students' design ability and computing ability of an important practical teaching. Through the forum and questionnaire survey of selected class students thoroughly understand their existing basic degree of electrical professional mastery, as well as the ability to systematically analyze problems, through repeated communication, to determine the task of moderate difficulty in the project, the distribution team to carry out research projects. In this way, we can learn from each other and help each other so that they can make progress together in the further study. To a certain extent, this also fosters awareness of the ability of students in teamwork.

Through the network and literature research, we can comprehensively and thoroughly understand the background of "CDIO mode" in domestic and foreign universities, summarize the achievements, find out the problems, find the problems and put forward the goal of inquiry. According to modern education concept, teaching concept, talent view, choose the appropriate operation and research methods.

Concept stage Teaching organization: teachers use modern teaching methods such as multimedia, blackboard and internet platform, through the implementation of specific projects, enable students to learn the basic theory of economic distribution of power plants and daily active load step by step. Given the original data of power system daily load three. The active power of a time period is shown in Fig. 2. And the various technical indicators of hydropower plants and thermal power plants, such as: rated capacity, daily water consumption, and consumption characteristics. Through various types of power plants and other active distribution of economic distribution of

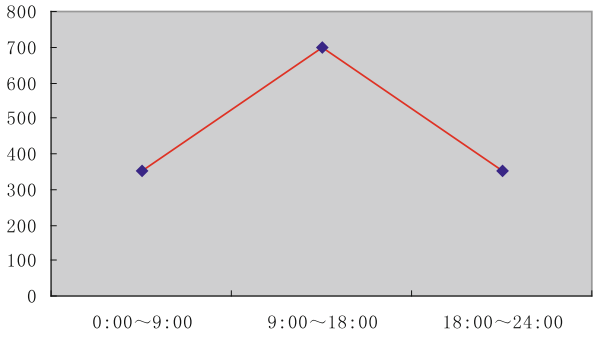

Fig. 2. System daily load power meter

practical training to enable students to grasp such as micro-incremental operating guidelines, and ultimately improve students' understanding of the economic distribution of power systems to achieve the goal of teaching knowledge of this course.

(2) **Design stage**

Constantly improve and perfect together to develop a viable design program, the group task refinement, to determine the project technical route and progress. At this stage, teachers should do a good job guiding students, students should take the initiative to learn, integration of knowledge system, constantly soliciting business experts advice and opinions at the same time, a comprehensive and systematic improvement of the subject.

Design Stage Teaching Organization: Teachers should actively listen to the students' design plan and work out a project implementation plan together with the students. During the implementation of the project, teachers should pay attention to the progress of the project, listen to the students' decision-making opinions, discuss with students to put forward feasible solutions, and help the students rectify the unreasonable decision-making.

(3) **The implementation phase**

According to the characteristics of the course, it is necessary to guide and solve the problems encountered, design and manufacture according to the product requirements of the project, establish and simulate the mathematical model and analyze it. The implementation phase of the project is more crucial. Teachers should supervise and urge all team members to communicate constantly and exchange opinions so as to better and faster find ways to solve the problem. Students should also broaden their thinking and not fight for themselves, appropriate organizational project seminars, repeated evaluation, feedback and correction, in order to achieve the best results with less.

Implementation Stage Teaching organization: Under the guidance of teachers, students establish the mathematical model of economic distribution of active load according to the implementation of the whole project teaching based on the original data, and obtain the equations of operation criterion such as micro-increment rate. Teachers on the selection of γ value and the system's full-time water consumption calculation, targeted guidance to help students solve the implementation process of γ value correction and encountered problems. In the specific implementation process, pay attention to improving students' enthusiasm for learning and ability to solve practical problems.

(4) **Operational stage**

After the design is completed, the project team provides the entity drawings such as the standard drawings and simulation models, as well as the analysis, summary report or essay to form the formative evaluation report. Students self-evaluation, teacher comprehensive points, and finally by the teachers, the community and students to discuss the project assessment of the proportion of each, to make an overall assessment of the results.

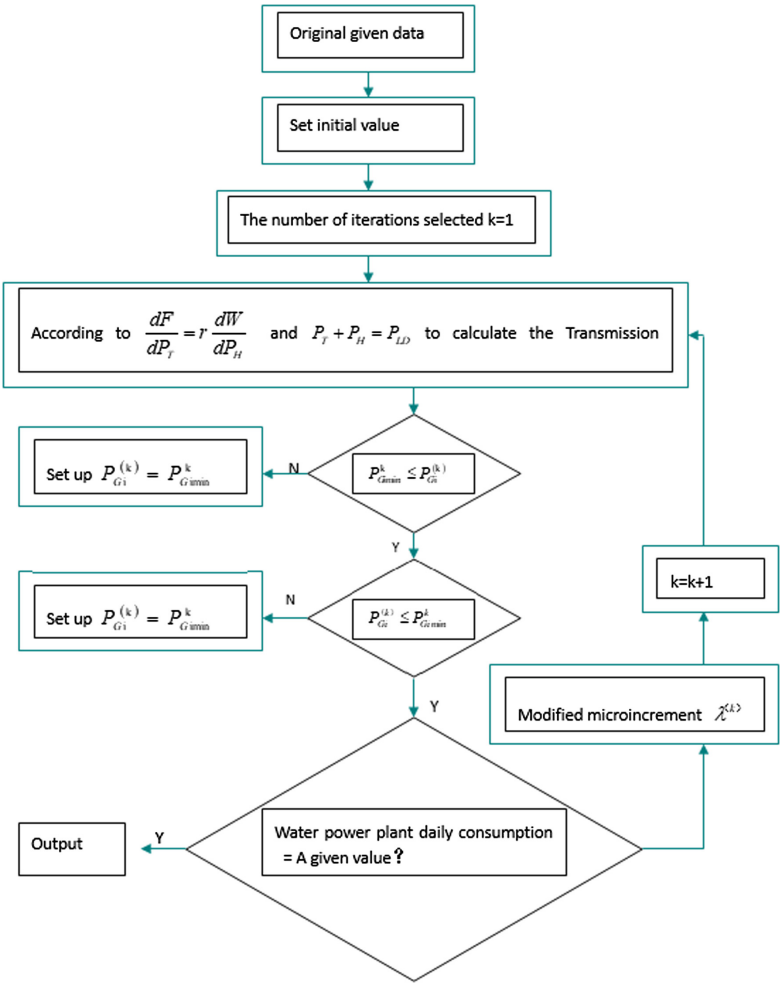

Fig. 3. Active load optimal distribution plan design

Operational Stage Teaching Organization: Teachers classify class students in specific teaching activities and require students in the same group to jointly design programs, prepare objective function procedures, constraint procedures and main programs so as to ensure that the output of thermal power plants and hydropower plants is basically the same in each time period. The optimal distribution plan is shown graphically. This not only fostered the ability of students to communicate, communicate and collaborate, but also help students to form innovative ability. Through the entire design process of teaching the implementation process, now the students initial results shown in Figs. 3 and 4.

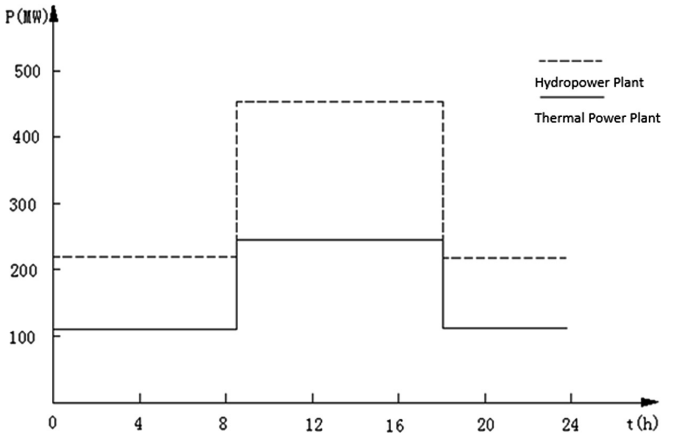

Fig. 4. Active load optimal distribution plan curve

From the design plan and program of economic distribution of active load between hydropower plants and thermal power plants, the final distribution plan of this design project is basically the same as the theoretical curve and the result is correct. However, in the design process complicated solution, the establishment of complex functions, the availability of MATLAB optimization and other issues worth pondering and research in order to better knowledge through and integration, so that CDIO model of education truly into the *power system analysis* course teaching.

5 Conclusions

The characteristic of CDIO mode teaching is to integrate the teaching process into specific engineering projects, cultivate the students' ability target around the project, organize teaching and targeted teaching, and achieve more remarkable results. The power system analysis course aims to cultivate high-quality skilled personnel who meet the needs of various industries in the region. The introduction of teaching philosophy of CDIO can fully mobilize the enthusiasm of students and further enhance students' hands-on ability.

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