This Teaching Practice Based on CDIO Engineering Education Reform Ideas

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ABSTRACT

The CDIO teaching philosophy is introduced to propose a teaching reform idea of “Classroom Trilogy" and” After-school Practice Trilogy” in accordance with characteristics of "Mechanical Engineering Testing Technology" course. The paper demonstrates the role and the correlation of textbooks, multimedia and research in the teaching process to help students obtain the necessary basic theory through a vivid teaching process. It introduces the after-class exercise “trilogy” to improve the students’ learning initiative. By introducing the engineering test content into experimental teaching, students’ self-learning ability, engineering consciousness and practical ability are developed in the implementation of three-level projects, it also cultivates students' creativity, design skills and team spirit by enabling students to receive a full training with a theory to solve engineering problems. The close combination of the engineering teaching mode with the "trilogy" plays an important role in cultivating good habits of active learning.

KEYWORDS

CDIO, the design of classroom teaching, experiment teaching, project-based teaching, standards: 1,2,3,6,8,11

1. INTRODUCTION

Engineering test is an important issue in engineering field and it is the basic skills that the science and engineering students must master. "Mechanical engineering testing technology" is a basic technology course for engineering students; the outstanding feature of this course is the wide range of knowledge, quick updated content, strong practicality. Therefore, the teaching content and teaching methods in the dynamic reform process should keep pace with the times to adapt to the growing training

requirements of "student capability matrix".

Based on the CDIO concept, through many years of teaching practice, we summed up the teaching method.

2. CLASSROON TEACHING TRILOGY

2.1 Based on the content of textbooks and we accept the disciplines of basic theories and basic concepts

The basic theory and concept is the cornerstone of the course. The basic task of classroom teaching must ensure that the students grasp the curriculum essence; we should not ignore the basic learning theory while emphasizing the improving of the practice. Students can master the basic theories of context through rigorous formula and theorem proving. Through which we can cultivate students' rigorous learning attitude and lay a theoretical foundation for the project-based teaching "ideas" and "design".

For example: The basic theory of this course-- time domain and frequency domain analysis of signals. This part of content is for students studying mechanical entity. Students often find it difficult to understand those invisible " signals ". In this regard, the author uses an instance of “feedback " theory teaching method. First of all, we use engineering test and get a lot of measured waveform and physical description of the signals, then using the virtual instrument technology to realize the transform of signal in time domain and frequency domain. Through visual effects, students establish a perceptual knowledge of the signal and then achieve sublimation from the perceptual to rational through theoretical derivation. At the same time, students can master the basic theory and basic methods of signal analysis by exercise training.

2.2 With the multimedia courseware development, we add new content and expand students’ horizons

As a modern means of teaching, multimedia technology plays an important role in improving the "mechanical engineering test technology" classroom teaching. First of all, we use it to transform some phenomena that can not be shown on the blackboard, difficult to convey or unable to be observed into animation, visual information or pictures. This can vividly be shown to the students. Secondly, we can visualize the dynamic testing process in engineering through the multimedia courseware and then help students set up the perceptual knowledge of engineering test. Thirdly, through the multimedia technology, we not only can expand the textbook content, but also introduce the research results of the field home and abroad and the teachers’ scientific research to their own students. We can use this teaching method to increase the

students' understanding of the university scientific research achievements.

For example: we use multimedia courseware to introduce the university's representative research achievements, such as "Heavy machinery dynamic characteristic experiment research and analysis method", "Cold rolled strip shape meter and closed loop control system", "Development and application of six-dimension force sensor" and so on. It greatly broadens the horizons of students, helps the implementation of the three projects and enhances students' self-confidence.

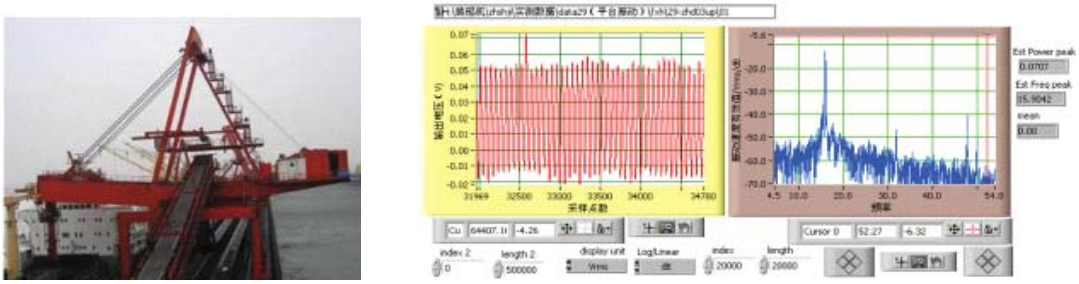
In order to improve the teaching effect of "trilogy", the teacher must carefully design the classroom teaching. What kind of knowledge to write down on the blackboard and what kind of knowledge to show to the students with courseware, then truly realize the complementation of the courseware and textbooks. At the same time, they should put innovation and personality into the courseware, master the technology of virtual instrument and visualize the boring theory content to avoid simply moving the content from the books to the screen.

2.3 Try to deepen the knowledge of the course to inspire students' creative thinking in the case of scientific research project.

In the "mechanical engineering test technology" teaching process, the engineering case teaching method has been accepted as the industry teaching means. The introduction of engineering case should be based on the teaching syllabus, and divided into several parts to make the project content organically integrated into teaching, eventually it enables the student to establish the system of test engineering concepts.

For example: in the teaching process we introduce the project of Vibration Failure Diagnosis of a Dock Loader Hoist Platform. According to the teaching syllabus and curriculum schedule, the content of the project is divided into three parts: that is to introduce the subject and use multimedia courseware description equipment in the study of signal analysis content; ask the students to predict the measured signal and imagine the signal properties after the necessary tips, then they should study on signal acquisition and processing program. Students should demonstrate sensor selection scheme when it comes to the chapter of sensor. After completing the course content of the test system characteristics, students are required to design a test plan and draw a block diagram and make a simple mechanical device to do simulation experiments to compare with the measured results of the project and then to discuss the similarities and differences. In this way, we have introduced the students to the specific project, so they will participate as a member of the project and give advice to the project. Eventually students' enthusiasm is greatly mobilized and we receive good teaching response. Some students directly choose mechanical equipment fault diagnosis as their postgraduate research directions. Figure 1 shows a typical project case, time

domain and frequency domain characteristics of the vibration signal of machine loading winch platform.



(a) (b)

Figure.1 Typical project case, vibration characteristics of machine loading winch platform Ship loader; (b) Time domain and frequency domain waveform of the vibration signal

Through the teaching method of "three steps", we have enhanced our engineering background of the course and emphasized the integration of theory with practice, we eventually lay a foundation for the cultivation of the students' ability in science and engineering.

3.AFTER-SCHOOL PRACTICE TRILOGY

3.1 Task Training

Task training consists of basic and expanding task training. Basic task training is the exercise and homework of the textbook as the main body of the task, this part of the task sticks to the basic theory and basic concepts. Students’ solid foundation is achieved by focusing on conceptual questions and drilling important exercises repeatedly.

(a) (b)

Figure.2 Expanding task training students’ reporting scene; (b) teacher summarizing students’ expanding job

Expanding task training is a typical test case which is beyond the content of the book

and closely related to production and life. Students work in teams to accept the task, to demonstrate the principles and methods, to describe signal analysis method and select test system in a form of a small test case papers, then they make a special report. We provide a platform for students to fully mobilize their enthusiasm to participate in teaching and discussion through this expanding task training. Meanwhile we have students to complete the comprehensive summary of the teaching content and train students' ability of summary and lecturing.

3.2 The experimental training

CDIO engineering education mode attaches great importance to practical teaching and ability, advocates students "learning by doing". Therefore, experimental training course is an important link of the after-school practice "trilogy". In order to strengthen the experimental engineering and follow the natural law of knowledge connecting link, we adopt double modular experimental scheme: the first module is a basic experiment module. It mainly includes the sensor working principle and calibration experiment, the data acquisition and analysis system based on virtual instrument and so on. The key is to develop students' basic experimental skills and deepen their understanding of the course content. The second module is associated with engineering testing experiment, which is the extension of basic experiment. The main experimental content: measure the structure's natural frequency, support the rotor dynamic characteristics experiment and experiments which is very close to the engineering test. In this module, students can also choose the topic and design their own experiments, at the same time, they also can put the experiment content of the course of three-level project into the module. We allow the students to do the experiment with a task, which fully mobilizes students' learning enthusiasm. Fig.3 indicates sensor and rotor dynamic experimental device designed by the students in the course of experimental training.

(a) (b)

Figure.3 Sensor and rotor dynamic experimental device designed by the students
Various sensor fabrication and calibration laboratory;
(b) Student homemade rotor dynamic characteristics experimental device

3.3 Three-level Training

Three-level project of the curriculum system is different from the field practice, the

operation and experiment course. It should be the deepening of the teaching content and the extension of the experimental teaching. It is an important means to cultivate students' engineering practice ability and team cooperation spirit.

In the implementation process of three-level project, we need to run through the ideas of CDIO. Therefore, the selection of three-level project not only should be a close integration of teaching content, but also should highlight the professional features. What’s more, it should have a certain nature of research. Through the three-level project, it should make the students to receive a full training with a theory to solve engineering problems, to achieve a deepening of knowledge, to use the least amount of class to achieve the best effect.

The three-level project selection of this course is mainly concentrated on the small topics which are related to testing and engineering, such as small electronic manufacturing, engineering vehicle cab vibration simulation experiment, vibration conveying machinery dynamic characteristics on the conveying process parameters, engineering machinery typical steel structure inherent frequency test, dynamic characteristic of lifting mechanism test analysis, multi-point shafting torsional vibration and the speed limit test and so on. Through the course of these three projects, students complete the project of Multifunctional Stroller Weighing Function Items and got the award in Hebei Province Mechanical Creative Design Competition, which is shown in Figure 4. Among them, Fig 4（a）are the stroller with features of weighting and climbing the building and its award certificates，（b）is the presentation of a variety of electronic scale works.

(a) (b)

Figure.4 Course and achievement of three-level projects

(a) Multi-function stroller and award certificates; (b) Student works show

The three-level project training has provided the students with a new platform on which they build the concept of projects, realize the abilities that engineers should possess, recognize the team wisdom and the individual value in the process of completing the whole cycle of a product. Teachers also guide the students toward the market and have the students to know the value of the products through market research，cultivate students' ability of marketing. Students put their intelligence and inspiration into the products produced in the three - level projects, they learned the spirit of novelty and innovation.

4 REFLECTIONS

Through the teaching trilogy, we successfully solved the conflicts of abstract theory, with diversified content and the non-practical experiment. We achieved the goals of having students to get a solid foundation, broadening their horizons, cultivating creative thinking, training their practical working ability. We narrowed the gap between teaching and engineering, trained students' consciousness of engineering and received good response from teachers and students.

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