

Exploration & Practice of Intelligent System Concepts Based on CDIO Mode

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Abstract—In this paper, “intelligent system concepts” curriculum, introduced from University of the West of Scotland, is used as the research platform. To cultivate the students’ learning enthusiasm, initiative, creativity and team work spirit, the setup of teaching contents, teaching method and evaluation way are explored and practiced based on the CDIO mode. Training students’ practical ability is the main line of setting teaching content; the task-driven PBL teaching method is adopted; evaluation way focuses more on the process evaluation. Through teaching practices, a better teaching effectiveness is achieved.

Keywords-CDIO; PBL; intelligent system concepts

I. INTRODUCTION

With the development of social economy, all walks of life are in urgent need of high-quality talents. It has always been a key issue of higher education exploration for cultivating good professional ethics, integrity, and professional quality, and innovation ability, team cooperation ability of students. Now all countries, especially the European and American countries, have paid much attention to the engineering education, to look forward to cultivating the high-quality engineering and technical talents. CDIO is a kind of engineering education concept based on the above goals. CDIO stands for Conceive, Design, Implement and Operate. It is the concentration generalization and abstract expression based on “learn by doing” and “Project -based education and learning”, and an education concept combined a practical education with theoretical education.

In this paper, the CDIO teaching mode is applied in intelligent system concepts course, which is introduced after the cooperation between the author’s school and University of the West of Scotland. It is offered in the first year in the mechanical discipline. It focuses on the introduction of the related concepts and techniques of intelligent robot to arouse the students’ interests and potentials. Due to robot is one of typical electromechanical integration products, the related course makes students learn a comprehensive understanding of the modern industrial design, mechanical, electronic, sensor, computer software, hardware, human-machine

interaction, artificial intelligence and other advanced technology, and contact and experience the modern high technology through the practice, moreover obtain knowledge and practical ability of science and technology. The following is the specific implementations of the teaching content setting, teaching method and examination way based on CDIO concepts.

II. SETUP OF TEACHING CONTENTS

The CDIO teaching mode, breaking the traditional patterns of the “lecture + experiment”, unites lectures and experiments. Teaching contents are set as follows. The baby car robot, shown as Fig 1, is used as the teaching object in the “Intelligent system concepts”. In this paper, mechanical, control and intelligent parts of robot system are introduced. Freshmen know not much about the professional knowledge of robots. The main purpose of this course is to make students understand related concepts and technology of the typical representative of the intelligent system-----the robot. The first part is to assemble the robot. Teachers teach while demonstrating the key areas. Students assemble robot with components, according to a given robot model, such as wheel, crawler, six claw type robot. After assembly, three softwares are learned by students themselves in the lab. Keil uVision2 IDE - the programming software, it is an integrated development system between 51 series single chip microcontroller and C language, produced by German Keil company; SL ISP- download software tools, it is an ISP (In-system Programmable) download software. The compiled executable files in the Keil can be downloaded to the robot control system; Serial debugger is applied to display the interactive information between the single chip microcomputer and computer, that is to say, it is applied to verify whether the program has been downloaded to the robots system.



FIGURE I. BABY CAR ROBOT.

The second part, the key components of the control part----the motor is introduced. Firstly the teacher introduces the basic knowledge of motor, and guides students connect the servo motor control line of the robot to the motor control interface of C51 teaching board; secondly according to the notes, students program on the single-chip and realize some basic cruise actions: move forward, move backward, turn left in situ, and turn right in situ. Tab 1 is the key program fragment of the different cruise actions. Through practices, students will find that more different robot cruise actions can be obtained by changing and combination delay_nus () parameters. The speed and time control of robot can be realized by the same way. By “doing ” and “learning”, the extrapolating ability is obtained.

TABLE I. KEY PROGRAM FRAGMENT

Cruise actions	Key program fragment
Move forward	P1_1=1; delay_nus (1700); P1_1=0; //Anticlockwise / left wheel P1_0=1; delay_nus (1300); P1_0=0; // Clockwise / right wheel
Move backward	P1_1=1; delay_nus (1300); P1_1=0; // Clockwise / left wheel P1_0=1; delay_nus (1700); P1_0=0; //Anticlockwise/ right wheel
Turn left in situ	P1_1=1; delay_nus (1300); P1_1=0; // Clockwise / left wheel P1_0=1; delay_nus (1300); P1_0=0; // Clockwise / right wheel
Turn right in situ	P1_1=1; delay_nus (1700); P1_1=0; // Anticlockwise / left wheel P1_0=1; delay_nus (1700); P1_0=0; // Anticlockwise/ right wheel

In the third part the intelligent part of the robot is introduced. The intelligence of robots mainly is reflected by the use of sensors. The teaching contents are designed as the following from simple to difficult. The simple task is that only the sensors are controlled by the programs without robot actions. Such as through LED flashing task, controlled by single chip microcomputer, students not only learn to realize the construction of the circuit on the breadboard but also intuitively feel the effect of the control software of hardware. The difficult task is to make programs to control sensors and robot simultaneously. The robot is guided to move by information acquired by the sensors, such as obstacle avoidance by tentacles and infrared sensors, escaping the shadow by a light sensor. Students not only can learn the construction of the circuit, but also debug program successfully. So the arrangement of teaching contents fulfills

the teaching mode: “teaching by doing, doing by teaching” for teachers, “learning by doing, doing by learning” for students.

III. CHOICE OF TEACHING METHODS

The PBL and task-driven teaching methods are introduced in intelligent system concepts course, that is, task-driven PBL teaching method. PBL is Problem -based Learning, also called problem-orientated teaching method, initiated by neurology professor Barrow at Harvard University in the United States in 1996. “Posing the problems” is taken as the starting point of learning, and “cooperative learning” is taken as the mid-term operation pattern, and “solving problems” as the goal. The PBL teaching method aims at cultivating the students’ ability of applying knowledge flexibly, autonomous learning, cooperative learning and presentation skills, and also lays the foundation for cultivating innovative and research talents. Different from the traditional teaching in teachers’ teaching mode, this method emphasizes that: on the basis of the problems; giving priority to the students’ active learning, reducing teacher’s dominant position; in the form of group discussion and cooperation are used as the main study mode. Since this method was put forward, it has become widely one of the teaching methods of medical education nearly 40 years. According to the above-mentioned characteristics of PBL teaching method, combined with the task driving mode, different teaching tasks are set in each class. For example use of infrared sensor obstacle avoidance task, using PBL inquiry teaching mode of “posing problems→ searching materials→discussion and research→summarizing reflection”, and the implementation process is as follows.

A. Posing Problems

When tasks are set, problem situation is set opportunely in the task. The essence of the PBL teaching method is that the problems of the learning process should play the role of navigation. The setup of the typical tasks is the key to achieve a better teaching effect. So the teacher must be well prepared for the design of the task in advance. During the teaching, the students are asked to realize a robot out of the maze by infrared sensors. In this task, students are required to design a maze, construct the infrared sensor circuit on the main body of the robot, and change some parameters to achieve this task according to a given reference program. In this way, the knowledge points, key and difficult points of this course are learned.

B. Searching Information, Discussion and Research

Students, divided into groups according to tasks, consult data and implement tasks. Groups are free to form, in which

team members mostly have similar hobbies, emotional compatibility. It is beneficial to cultivate students' personality and team cooperation ability. The First task for students is circuit construction. In order to complete circuit construction, students have to search materials for the precaution of no soldering bread circuit construction and the working principle of infrared sensor. For obstacle avoidance program, students should discuss the robot action strategy for the left, right, and both sides of the infrared receiving signals, and the degree of correlation between them. That is to say, when the robot encounters obstacles; it should get out of the maze guided by infrared sensors.

C. Summarizing reflection

For common problems, teachers need to guide and comment fixedly, analyze the feasibility of the solution, and encourage the students to validate them. Even failed plans need to be discussed the failure causes. In this way, it is easy to deepen students' understanding. The teacher should accept and inspect the completion of the tasks for each group and make a fair evaluation, and be good at discovering each student's strengths which need to be encouraged and praised. Task completion and discussion are the important basis of the groups and individual evaluation.

Based on the task-driven teaching mode, PBL is carried. Questions are implied in the task. Through the better interaction in classroom, self-study, cooperation ability, language expression and innovative thinking ability are cultivated for students, and also students' learning enthusiasm is motivated. The students learned the joy of the cooperative learning and problem solving. At the same time, teachers also can be spurred to improve themselves. This course fulfills the CDIO education mode through choosing the PBL combined with task-driven teaching methods.

D. Evaluation Ways and the Effect

Appraisal purpose is to promote learning and teaching

through exams, standardize teaching, strengthen the learning motivation, guide and supervise the students' initiative to practice and earnest study. During implementation of the project, firstly the students complete the brain steps of "Conception" (C) and "Design" (D), then gradually develop practice training steps of "Implementation" (I) and "Operate" (O) aspects, that is, the complete training of CDIO required four abilities is obtained. Therefore, the traditional evaluation way in the form of written test is abandoned. Attendance, observation, on-site supervision and the computer examination are adopted. Attendance evaluation is to check if students are late, leave early or absentee. The weight is 5%; Observe inspection is conducted to supervise the student's attitudes and performance assessment, and whether the students complete the task seriously, if there is a team work, environmental protection and safety consciousness. The weight is 10%; On-site supervision is to evaluate the results of the completed each task of each student. Marks are given through the quality of the completed tasks. The weight is 55%; Computer test is a kind of spot check examination to check students' grasp. The different key contents are edited into examinations. Students obtain test paper by drawing lots to realize the robot control with a computer. The weight is 30%. When evaluating marks, marks of each item are assessed for five-level grade. Then according to the weight of each item and convert standard (excellent- 95 points, well - 85 points, medium -75 points, poor-65 points, fail - 0 points), the centesimal grade is calculated by the weighted summation method. Finally according to the corresponding standards, the calculated mark is converted into five-level grades.

By the distribution of student performance in recent years, the evaluation way based on process achieves the better effects. Tab 2 shows students marks distribution of intelligent system concepts in nearly three semesters. Seen from Tab 2, "excellent" and "well" proportion are more than 45%. In 2012/2013 (1) semester, mechanical manufacturing and automatization class 1142 and 1143, the number of failed students are 10, but including 3 students transfer, 1 student absence, so the failed ratio is somewhat higher.

TABLE II. STUDENTS MARKS DISTRIBUTION

2011/2012 (二)class 1141		2012/2013 (一)class 1142/3		2012/2013 (二) class 1241	
Marks	Number/percentage	Marks	Number/percentage	Marks	Number/percentage
Excellent	6/20.00%	Excellent	14/18.92%	Excellent	6/17.14%
Well	12/40.00%	Well	20/27.03%	Well	16/45.71%
Medium	12/40.00%	Medium	17/22.97%	Medium	12/34.29%
Poor	0/0.00%	Poor	9/12.16%	Poor	1/2.86%
Fail	0/0.00%	Fail	10/13.51%	Fail	0/0.00%

In addition, by the students' awards of the different mechanical innovation competition awards, the evaluation method is verified based on CDIO concept. It can improve students' innovation consciousness and ability, cooperation spirit and practice ability. Students' 27 works from 2010 to 2012, eight of them won the national awards, and 19 items won the provincial level awards. Tab 3 lists some students'

works and awards in a different time for the different contest and organizers.

TABLE III. STUDENTS' WORKS AND AWARDS

Students' works and awards				
Time	Contest name	Organizers	Title of entry	Awards
2010	The 4th national college students' Mechanical Innovation Design Competition (Fischer group)	State education commission	Mine dredging machine	National prize 2nd
			Elevating the rescue ladder	
	Chinese robot Wushu challenge cup	Chinese automation society	Fearless construction brigade	National prize 2nd
			Raptor MT team	National prize 3rd
2011	National college students' Mechanical Digital Design Competition	State education commission	Fdzccit	National prize 2nd
			Tango No.1	
2012	The 5th national college students' Mechanical Innovation Design Competition (Physics group)	Jilin province education department	Automatic Ricer box machine	1st prize at the provincial level
			New -type skateboard machine	
			Window SMS remote control device	
			Human-machine coordination exercise bike	
			Plastic recycling bin	

IV. SUMMARY

As one of engineering majors, mechanics has very strong practicality. According to course characteristics of intelligent system concepts, the CDIO teaching mode is introduced. This mode emphasizes not only the cultivation of the basic knowledge, basic ability, basic skills and basic quality, but also the cultivation of scientific and rigorous work style, team spirit and the form of individual high-quality. The setup of teaching contents, teaching method and teaching organizational form and the evaluation methods reflect teachers' "Conceive→Design→Implement→Operate". In the first place, in the form of team work students complete the thinking training of "Conceive" and "Design", that is to exercise the students' ability of analyzing and solving the problems; then gradually develop the practical training of "Implement" and "Operate", namely to train the taking action's ability. In the whole teaching process, teachers and students implement CDIO completely. Individual ability is improved and the teaching quality is enhanced.

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