

## **Research on the teaching reform of a *Single Chip Microcomputer* course based on the concept of CDIO**

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**ABSTRACT:** *Single Chip Microcomputer* (SCM) is an important specialised basic course for electrical and electronics majors in colleges and universities, and it is a strong theoretical and practical course. The approach in this course should be to pay particular attention to enhance students' hands-on ability. In this research, the current situation of SCM teaching was analysed, then, three aspects of reforming the SCM course, such as teaching content, teaching methods and examination methods were devised, explored and proposed, based on the advanced concept of CDIO (Conceive, Design, Implement, Operate). The practice of SCM course teaching shows that the effects of this teaching reform were able to demonstrate considerable improvements in terms of students' outcomes and teaching efficiency.

### INTRODUCTION

SCM has been widely used in industrial inspection and control, instrumentation, consumer electronics, communications, weapon and equipment, and so on [1][2]. SCM is an important specialised basic course in engineering majors for such specialities as electronics, electrical engineering and automation. Mastering the SCM technology is not only helpful for improving students' practical ability, engineering thinking, innovative consciousness and cooperation ability, but above all to improve the competitiveness in employment. Therefore, it is very important to do well in the SCM course teaching.

In this article, the authors demonstrate how they first analysed the current situation of SCM course teaching and, then, determined and proposed a teaching reform with three important aspects, such as teaching content, teaching methods and examination methods based on the advanced concept of CDIO (Conceive, Design, Implement, Operate). Every method is expounded in detail in this article.

### SCM TEACHING SITUATION

Apart from being theoretical and practical, the course is highly abstract, teaching and learning is hard, students exhibit a low study interest, and so on. All these seriously affected the teaching outcomes of this course. Before the reform, there were several problems in SCM teaching [3-5], as follows:

- Arrangement of teaching content was not rational - theoretical teaching was conducted according to the order of the chapters in the reference textbook, each bit of the knowledge learnt was somewhat independent, so that after finishing the course, students could not grasp the concept of the entire process of SCM product development. This had led to a grossly reduced learning interest of the students.
- The teaching methods were far too simple and teacher-centred - students were sitting and listening, the participation was poor and students' study enthusiasm was grossly reduced.
- The theory and experimental arrangements were not rational - there were more theory lessons, less experimental lessons, and the theory and experimental lessons were carried out separately. Most of the experimental lessons were demonstrations of experiments and were not designed for students to carry out experimental work. The existing experiments for students were structured as a step-by-step procedure, mostly according to experimental textbooks. There was a lack of independent thinking, which had caused students' inability to design the circuit and determine programming, so their practical ability was not improved.

- Examination methods were not particularly sophisticated - an examination is an important means to test the students' learning achievements, by only arranging a final examination at the end of a term was disadvantageous for students; it was not necessarily an objective and comprehensive reflection of the true level of students' attainment, and students often received good results, but were unable to demonstrate their practical ability.

## TEACHING REFORM OF SCM COURSE BASED ON THE CONCEPT OF CDIO

CDIO (Conceive, Design, Implement, Operate) is a kind of advanced engineering education concept. It is a generalisation and abstract expression of *learning by doing* and project-based learning. It takes the life cycle of a product from the research stage through the development to its operation. This system allows students to be able to actively study and practice the organic connection between courses on engineering [6-8]. Based on the advanced concept of CDIO, the SCM course teaching was reformed, including the teaching content, teaching methods and examination methods.

## TEACHING CONTENT REFORM

A project-based strategy was used in teaching, according to the students' cognitive regularity, from simple to complex and from single to comprehensive reform of teaching content. The teaching content was divided into four parts, that is, a basic module, a core module, an integrated module and an enhanced module. Each module was composed of several projects, and each project was organised in the following order: needs analysis, proposed project, project analysis, related knowledge teaching, project implementation and project examination. Table 1 shows the teaching content, whereas Figure 1 shows the application of CDIO in SCM teaching.

Table 1: The teaching content.

Module	Project name	Project description	Related knowledge	Practical ability
Basic module	Looking for the SCM in life	Describe how the fridge works	The SCM pins, memory structure and minimum system	Correct use of Keil and Proteus software
Core module	Flowing water light	Eight LEDs flowing from right to left	Led related knowledge	Circuit design, programming
	Digital tube dynamic display	Dynamic displays 1234 56 in 6 digital tube	Digital tube dynamic display principle	Circuit design, programming
	Elevator floor displays	8*8 dot matrix scrolling displays floor numbers	Dot matrix working principle	Circuit design, programming
	Simple stopwatch	Cycle display 00-59 in the 2 digital tube	Timer/counter principle	Timer/counter, programming
	Controllable neon lamp	Add a button in the flowing water light circuit, when the button is pressed, 8 LEDs light on and off 5 times at the same time	The SCM interrupt system	Interrupt system, programming
	Serial communication	Communication between SCM and PC	Serial port operating principle	Circuit design and programming
Integrated module	Keyed stopwatch	Two digital tube display 00-59, using 4 keys control plus, minus, clear and pause	Integrated application of digital tube dynamic displays, timer/counter and interrupt knowledge	Circuit design and programming
	Remote control of traffic lights	Design a remote control of traffic light system through serial port	Integrated application of LED, Digital tube dynamic displays, timer/counter, interrupt and serial knowledge	Circuit design and programming
Enhanced module	Design and manufacture a temperature alarm system	The upper and lower limits of temperature can be adjusted, the LCD1602 displays temperature value	DS18B20 and LCD1602 working principle, buttons, led, etc	Apply the knowledge of the course

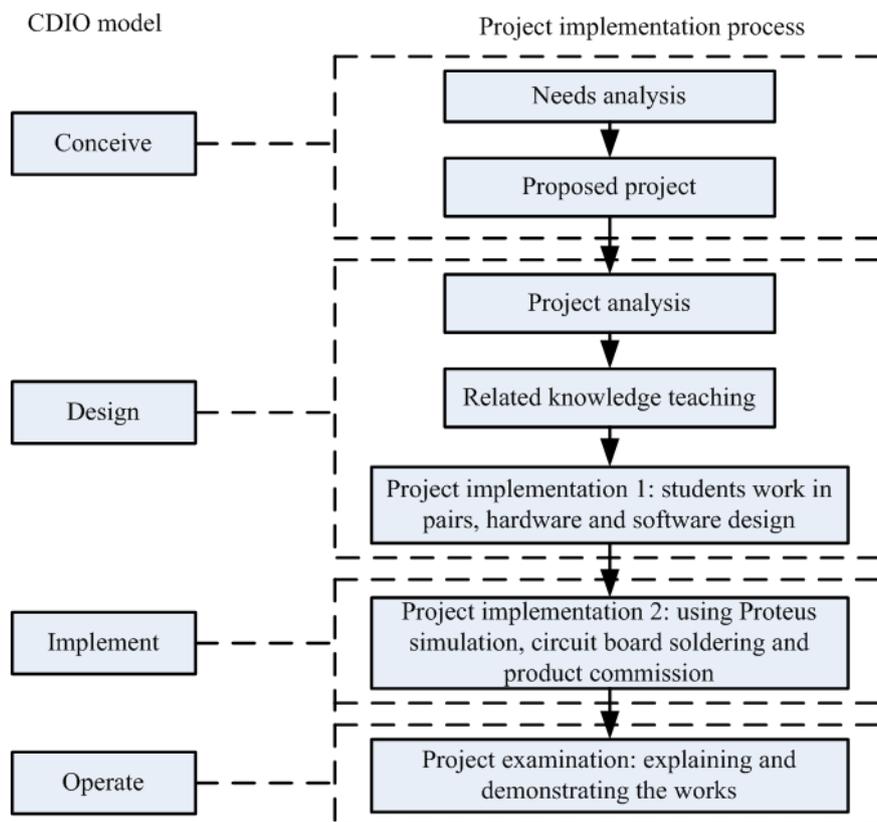


Figure 1: The application of CDIO in SCM teaching.

#### TEACHING METHODS REFORM

The traditional teaching methods, which were teacher-centred have been changed and team teaching methods have been adopted, with each team being made up of three to four students. Each project was completed by a team, and it was arranged for a team member to demonstrate and expound on the project's work. The students participated in the whole process of project conduct, and this could increase students' achievements and fully mobilise their enthusiasm and initiative, from *want me to learn* to *I want to learn*. After completing each project, students fill in a self-assessment form and a peer-assessment form. In this way, they would know their learning situation now and improve it in the future, if needed. Teachers should also evaluate students, they would know students' learning situation now and improve the teaching methods in the future, if required.

Through this teaching methods reform, the experiments were integrated into the classroom teaching, and knowledge points were hidden in the project implementation process. Also, the traditional theory and experiment separation was remedied. Teachers gradually transformed from a dominant role to a role in which students gradual transition to become dominant. Through *learning by doing* and *doing by learning*, students' interest in learning, their practical ability, analysis and problem-solving ability, and team cooperation ability have been improved.

#### EXAMINATION METHODS REFORM

Examinations are an important means to test the students' learning situation. Examinations should be a comprehensive and objective reflection of the students' mastery of knowledge, practical ability and team cooperation skills. The traditional examination methods were reformed. The new examination methods used a process examination as the primary and the final examination as the secondary. The examination process consists of each project examination, which is composed of self-assessment, peer-assessment and teacher-assessment. Teachers supervise and guide the students' self-assessment and team peer-assessment. The entire process of examination includes the following:

- Self-assessment: students assess themselves with respect to the learning attitude, professionalism, working ability, learning effect, etc. Self-assessment accounts for 20% of each project process examination.
- Peer-assessment: members of the team carry out a mutual assessment with respect to learning attitude, team cooperation, professionalism, working ability, learning effect, etc. Peer-assessment accounts for 30% in each project process examination.
- Teacher-assessment: teachers assess the students with respect to their attendance, operation, defence, experimental report, etc. Teacher-assessment accounts for 50% in each project process examination.

- The final examination is open in the form of reply. Students choose a project and complete it; writing design instructions and making their report as a presentation in PowerPoint (PPT), is an integral part of the examination. In reply, students first report and demonstrate their work; then, teachers ask one or two questions. Teachers assess students' performance with respect to the students' work execution, answering questions and writing instructions.
- The students' course score is composed of the process examination (70%) and final examination (30%).

### SCM TEACHING REFORM IMPLEMENTATION EFFECT

The teaching reform of SCM, based on the concept of CDIO, has greatly stimulated the students' interest in learning and has increased their learning initiative. As a result, students' practical ability has improved significantly. Two photos were chosen from the students' practical operation photos, which are shown in Figure 2, and two students' works were chosen, which are shown in Figure 3.

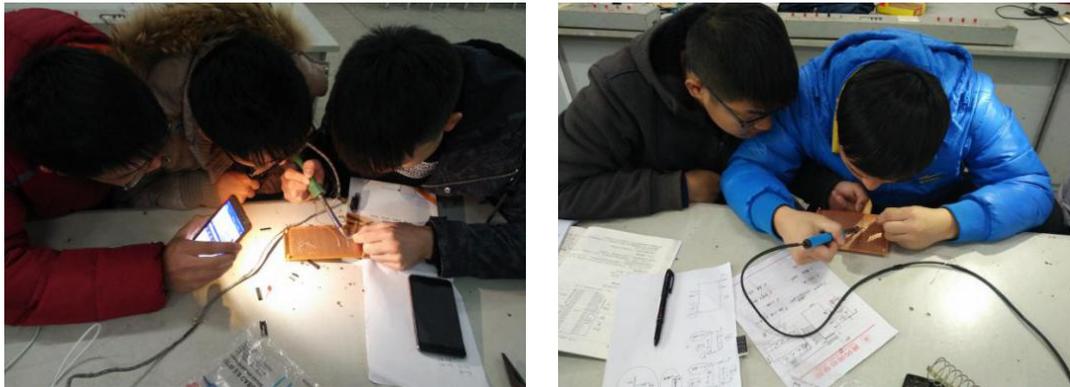


Figure 2: Students' practical operation.

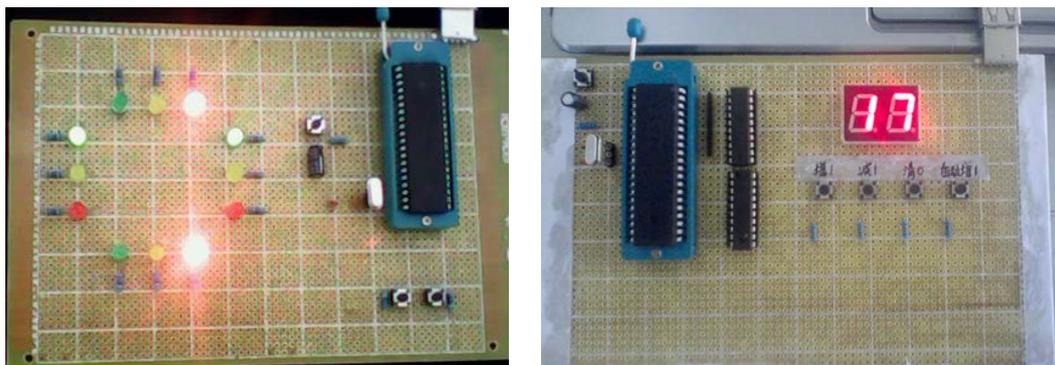


Figure 3: Examples of students' works.

### CONCLUSIONS

The current situation of teaching SCM was analysed, and teaching reform based on CDIO was expounded in detail. The teaching reform has embodied student-centred, learning by doing, doing by learning and project-based learning, which were the concept of CDIO.

Based on teachers' observations and students' results, it can be concluded that the students' interest in learning, practical ability, analysis and problem-solving ability and team cooperation ability have been greatly improved, and the teaching effect has been significantly improved.

### ACKNOWLEDGMENTS

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