Research on Teaching Reform and Practice of Single Chip Microcomputer

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Abstract. In view of the common problems in the teaching of single-chip microcomputer in undergraduate colleges, the teaching mode of single-chip microcomputer course is driven by projects and based on competition is proposed, and the experimental training content is integrated into the teaching of single-chip microcomputer course, and the subject competition is used as the platform of single-chip microcomputer teaching, so as to cultivate the students' comprehensive design and application ability of single-chip microcomputer.

Introduction

With the continuous development of the modern electronic technology and single-chip microcomputer with its unique structure and performance, has small volume, strong function, high reliability, oriented control and low prices and a series of advantages, widely used in industrial production of real-time control, intelligent instrument and meter, communication and other fields, become the indispensable important tool in today's modern science and technology, has a strong practical significance \cite{1, 2}. Therefore, the course of single chip microcomputer is a highly technical course which must be mastered by students majoring in automation in various universities. It plays a connecting role in the whole teaching system. Through the study of this course, students can fully master the basic structure, working principle, interface technology and design method of programming language of single chip microcomputer, cultivate students' design ability of integrated application system of single chip microcomputer. It can provide students with a solid foundation for the study of follow-up courses and practical work in automation system and related fields. This paper puts forward the reform of the teaching mode of single-chip microcomputer course, which aims at cultivating students' practical ability and innovative ability. It explores not only the content of experiment and training into single-chip microcomputer course teaching, but also the teaching activities of single-chip microcomputer and related discipline competitions, so as to achieve the teaching goal of learning now and using it in practice \cite{3}.

Disadvantages of SCM Teaching

The teaching materials used in the single-chip microcomputer course overemphasize the integrity of the knowledge system and the theoretical teaching, and the students in the classroom are in a passive state of acceptance, unable to actively participate in the whole teaching activities. The teaching activities cannot achieve the training of students' practical operation ability \cite{4}.

Theory teaching and practice teaching are separated. Theoretical teaching and experimental teaching are carried out in different places and at different times, and the teachers are also different. The experiment course mainly provides simple confirmatory experiments of theoretical knowledge. The students carry out the experiments step by step on the experiment box. The experiment content is simple, the function is limited, and the experimental equipment is old, which cannot reflect the outstanding features of the current single-chip microcomputer with strong functionality and practicability, and the comprehensive design experiments of the system cannot be realized. The experimental teaching fails to achieve the teaching goal of cultivating students' comprehensive design ability of single chip microcomputer system.
The assessment method is old-fashioned and unitary. The form and content of the examination are mainly based on theory, and only one test paper defines students' ability, which does not reflect the practical ability of examining students' practical application knowledge.

How to build a good teaching mode of single-chip microcomputer and make the course of single-chip microcomputer become a good platform for students to cultivate comprehensive application and design ability is the key to reform the teaching mode of single-chip microcomputer course.

Reform of Teaching Mode of MCU

In order to improve the teaching effect of single-chip microcomputer course, achieve the teaching goal of single-chip microcomputer course, and enable students to really apply what they have learned, we have created a single-chip microcomputer course teaching mode driven by projects and based on competition platforms. It has formed a theoretical and practical teaching system based on the combination of theory and experiment, learning process and subject competition. This kind of teaching mode has already achieved some excellent teaching results.

Combining theoretical teaching with experimental teaching, implementing the teaching mode driven by projects and based on subject competitions. Integrate the theory teaching and practice teaching organically, break the curriculum system, realize the teaching method, move the theory classroom into the computer room, and make the theory teaching and experiment teaching organically integrated. The teaching mode "driven by projects" transforms the knowledge content in the single-chip microcomputer system into several teaching projects. Each "teaching project" is a function or basic knowledge point of the single-chip microcomputer, and also a classroom experiment. Around the specific single-chip teaching project to organize and carry out teaching activities, so that students directly participate in the whole process of teaching projects.

Table 1. Single Chip Teaching Project Breakdown.

| Serial number | Modular                                      | Project                                                |
|---------------|----------------------------------------------|--------------------------------------------------------|
| Module 1      | Environment test of MCU development          | Installation and configuration of Keil and Proteus      |
|               |                                              | development environment                                 |
|               |                                              | The minimum system design of single chip microcomputer |
| Module 2      | Reset of single chip microcomputer and clock circuit | C51 programming                                      |
| Module 3      | Instruction system of single chip microcomputer |                                                        |
| Module 4      | The input and output circuit of single chip microcomputer | Square wave output with adjustable frequency and duty cycle |
| Module 5      | Interrupt system of single chip microcomputer | External interrupt and its extension                    |
| Module 6      | Timing and counter of single chip microcomputer | Universal clock                                        |
|               |                                              | PWM output                                             |
| Module 7      | Serial communication of single chip microcomputer 1 | Serial asynchronous communication                      |
| Module 8      | Serial communication of single chip microcomputer 2 | SPI communication, I2C communication                   |
| Module 9      | Design of integrated system of single chip microcomputer | Comprehensive application design                      |

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The knowledge points of single-chip microcomputer are divided into nine modules, each module corresponds to a project, and the teaching mode "driven by projects" is introduced, as shown in Table 1. That is to say, every teaching experiment is organized around a project and related knowledge and skills are explained. This kind of hierarchical structure is beneficial for students to learn how to use knowledge comprehensively from simple to deep, and finally master the basic knowledge, key technologies and methods of SCM application as a whole. It not only enhances the students' enthusiasm, sense of responsibility and sense of urgency in doing experiments, but also improves the students' hardware operation ability and programming skills. At the same time, the establishment and implementation of the teaching mode "driven by projects" enable students to master and improve their theoretical knowledge, basic experimental skills and practical ability.

2. the teaching mode "driven by projects" is a way of teaching with the goal of cultivating ability, students as the main body, quality as the basis, project as the carrier, action process as the way and teacher-student interaction as the teaching method. The following takes the design of the digital clock based on the single-chip microcomputer (integrated design of the single-chip microcomputer system) as an example to explain the realization steps of the teaching mode:

1) Assigning tasks
Before this project, the teacher should first give the students a task description, and ask the students to collect relevant information, such as the concepts of interrupt, timer, display, peripheral drive, the working principle of digital clock, software and hardware design ideas, etc.

2) Telling the key points of knowledge
Before class, the teacher arranges all the knowledge points involved in the task into multimedia courseware, and decomposes the task into multiple levels and scenarios to facilitate classroom teaching.

3) Using software tools to improve the teaching effect and complete the simulation demonstration of “project.”
In class, students use Proteus, Keil C51 and other simulation software to design the hardware and software of digital clock. Using Proteus to design and draw the hardware circuit, Keil to design and debug the software. Finally, the hardware and software are combined to realize the whole simulation process of the digital clock.

4) The physical production is the key step of the teaching method. Therefore, if conditions permit, students are required to make physical objects and debug, complete the whole task, and let students truly experience the whole construction process of single-chip microcomputer system from scratch. In the process of physical production and debugging, students apply the existing professional knowledge, understand and grasp the knowledge and skills required by the course, cultivate the ability to find, analyze and solve problems, and experience the hardships and fun of project implementation.

3. Breaking away from the conventional examination mode, instead of carrying out the boring theoretical examination, we have made bold innovations in the examination form, as follows:

1) Classroom assessment (60%)
In classroom teaching, we should give full play to the enthusiasm of teaching and learning, and give students' individual or group classroom assessment results when students explain the relevant concepts, working principles, software and hardware design of tasks and task demonstration.

2) Final exam (40%)
Based on the item of module 9, a typical software and hardware system of SCM application system is designed. Students are required to make physical objects, demonstrate the function of the system, and make a reply to assess the comprehensive application ability of students.

4. Encouraging students to participate in the innovation and competition links related to all kinds of single-chip computers, so that students can further improve the design and production ability of the application system of single-chip computers on the platform of all kinds of competitions, forming a benign learning process of learning by competition and learning by competition. On the basis of the previous course, students have a clear concept of the application of single-chip microcomputer, the construction of the system and the programming of the system, and have
independent design and production ability for the application system of the actual single-chip microcomputer. When the students enter the third grade, they can use their accumulated knowledge to actively participate in all kinds of project declaration and electronic competition. Teachers should actively encourage and guide students to participate in projects or competitions, realize the embodiment of their own values and ability improvement, and do a good job in the reserve of all kinds of competition talents. Through the innovative design, optimization and improvement of specific products, repeated modification of design process, and continuous optimization and debugging of software, students' practical ability and innovative thinking are further improved.

**Conclusion**

To overcome the disadvantages of the traditional teaching mode, to build the teaching mode of MCU “driven by project and oriented by competitions,” to reconstruct the teaching practice content and curriculum plan of the single-chip computer course, to establish a new assessment mode, aiming to cultivate the application-oriented talents with strong engineering practice ability. Through the reconstruction of the teaching system of single-chip microcomputer course, the students' independent learning ability, the comprehensive design and development ability of single-chip microcomputer are improved, the students' enthusiasm for learning is increased, and the results of participating in the subject competition are improved.

**References**

[1] Qin Yujie. The practice of the course reform of single chip microcomputer introduced in the information teaching—take the static display of nixie tube in the principle and application of single chip microcomputer as an example. J. Light Industry Science and Technology, 34 (2018) 161-163.

[2] Zhou Guanling. Discussion on the teaching reform of the course of principle and application of single chip microcomputer. J. China Educational Technology, 2012 (6).

[3] Sun Changwei, Wang Yanchun and Huang Yinghui. The curriculum reform of single chip microcomputer technology guided by the cultivation of students' engineering practice ability. J. Journal of Baicheng Normal University, 32 (2018) 27-31.

[4] Zheng Hongqing, Cheng Wei, Cai fan, Han Zhigang and Zhang Hongjie. Research on teaching reform of single chip microcomputer course with "subject competition as platform and application ability training as core." J. Equipment Manufacturing Technology, 10 (2018) 179-181.