Exploration on Teaching Reform of Embedded System Design Course Based on Innovation and Entrepreneurship Background

Lijuan Wang\textsuperscript{1,a} and Junnian Gou\textsuperscript{2,b}

\textsuperscript{1,2}School of Automation and Electrical Engineering, Lanzhou Jiaotong University, 118 Anning West Road, Anning District, Lanzhou, Gansu, China

\textsuperscript{a}wanglj@mail.lzjtu.cn, \textsuperscript{b}junnian@mail.lzjtu.cn

Keywords: Teaching reform, Embedded system design, Innovation and entrepreneurship.

Abstract. Under the background of innovation and entrepreneurship in China, cultivating innovative and entrepreneurial talents in colleges and universities has become a major trend of reform and development. Based on the educational concept of innovation and entrepreneurship, the thesis analyzes the existing teaching situation of embedded courses, and proposes reform measures from the aspects of teaching content, teaching method, experimental plan and evaluation method.

Introduction

With the implementation of innovation-driven development strategy in China, cultivating innovative and entrepreneurial talents in the new era has become a general trend of college teaching reform and development [1]. Curriculum is the basic element to achieve the goal of talent cultivation. Curriculum teaching is the foundation of school teaching activities. Curriculum construction is the important content of school teaching infrastructure and is the foundation and key of specialty construction and discipline construction. Embedded system design is a strong application-oriented course. How to integrate innovation and entrepreneurship elements into the course teaching and how to help students cultivate innovative consciousness and innovative thinking when students learn the system design method are the problems that teachers need to consider.

Teaching Situation of Embedded System Design Course

Embedded system design course is a professional basic course of automation and information. Embedded system is mainly used for various signal processing and automatic control, which has been widely used in national defense, national economy and social life, and so on. It requires in the course that through combining theoretical teaching and practical operation, the students can understand and master the principle and application method of embedded processor, and can understand preliminarily embedded systems architecture, ARM architecture, embedded system software design, embedded system hardware design, embedded operating system, and embedded system programming languages, etc. It hoped that students can have the ability to do the basic embedded system hardware design and maintenance and configuration the embedded system equipments. The course has obvious engineering technical characteristic, and has the high demand to the students' practical ability.

The course is offered to all professional classes in the school of automation and electrical engineering in Lanzhou Jiaotong University during the second semester of the junior year. The course is planned to be 32 hours, covering embedded system hardware design, operating system, embedded development environment construction and operating system tailoring and transplantation. Three experiments is included in the course plan, each of which is 2 hours. The experiment content aims to help students form a preliminary understanding of embedded development. The embedded system design course, which can deepen the teaching of the operating system core, is given after the single chip microcomputer course. So that the embedded course is comprehensive, the content is broad, the hardware and software are included, the practice is strong,
and the study threshold is high. However, there are some problems in actual teaching, such as fewer teaching hours, more difficult theoretical content, single teaching mode and solidified assessment methods, which make it difficult to meet the guiding ideology of innovation and entrepreneurship and the training requirements of engineering certification for students. On the other hand, due to the limited class hours, students can only understand the most obvious technology and concept from the classroom teaching, which makes a certain gap with the requirements of engineering practice.

**Embedded Curriculum Construction and Teaching Ideas**

In view of the problems existing in the current course teaching, combined with the teaching situation of the existing course system and students' participation in discipline competitions and innovation and entrepreneurship projects, it is considered that the following five aspects can be improved and adjusted. The content of course construction is shown in figure 1.

---

**Teaching Content**

In order to combine the teaching content with the rapidly developing industrial technology application, NXP K60 chip was selected as the teaching chip [2]. The chip adopts ARM Corte-M4 core with abundant pins and enhanced functions. The course content takes the design experiment of intelligent tracking car as the main line, and explains demand analysis, function decomposition, unit module design, overall design, etc, which are coordinated with the experiment. On the basis of the completion of the intelligent car basic functions, the content will add such knowledge of embedded microprocessor, instruction system, embedded operating system, embedded development environment and so on. By organizing and arranging the teaching content from these above aspects of, we can improve or adjust the existing teaching content so that students' fear of difficulties can be reduced, students' participation and achievement can be increased and the curriculum learning interest can be enhanced. Since students have already had certain experiment operation foundation in the course of single chip microcomputer in last term, the embedded course is well connected and excessive with the content arrangement. In the learning process students can gradually learn the design method and master the design concept of embedded system. In the process of improving the intelligent car step by step, students' innovative thinking is constantly stimulated. The teacher can guide students to consider what functions can be added or improved from the perspective of users, what hardware and software are needed to realize these functions, and where to start to modify in order to achieve the better efficiency. From the perspective of producers, how to design can reduce costs and improve the cost performance of design works. In the process of gradually promoting course teaching, we should try to cultivate students' innovative thinking and entrepreneurial ability.
Teaching Method

In the teaching process, some special teaching methods will be tried. The problem-oriented method will focus on some engineering cases. The finding problems method, the heuristic method, the discussion method and the inverted classroom will take the student as the main body, and take the teacher as the leader. It will arouse students' study enthusiasm, improve the ability of students to find, analyze and solve problems.

The teaching method will use PPT combined with blackboard writing. In addition, demonstration teaching is adopted for some operations, so that students can see the operation process and results. At the same time, they have a perceptual understanding of what they have learned, which is helpful to grasp the operation steps in the experiment.

Classroom teaching introduces some classic cases of previous discipline competitions, which can explain and analyze the whole process of embedded development through requirements analysis, overall design, hardware design, software design, integration test, and so on. The teacher can take similar topics as cases, guide students to design and discuss in groups. The design is submitted in the form of large assignments, and the discussion is conducted in the form of students' classroom presentation and explanation.

Experiment Plan

Embedded system design is a practical course, so the experiment is an important part of the course. At present, there are 3 experiments in this course. There are 2 hours for each experiment and there are 6 hours in total. The content includes a preliminary understanding of Linux system, the construction of cross-compilation environment, embedded Linux application development program examples. The three experiments is gradually progressive at the level and gradually increasing in the difficulty. Through the experiments, students begin to have a general concept of embedded development. However, students' understanding of embedded development is still in a state of ambiguity due to the lack of further development.

The experimental teaching part is adjusted and modified in this program. It is planned to increase the original 3 experiments to 8 experiments which is 2 class hours for each and is 16 class hours in total. The experiment content is refined and supplemented on the original basis, and a series of experiments are added with the design of automatic tracking intelligent car as the main line. The experiment content starts from the given application background. Firstly, students can do the demand analysis, which can make the student carry on the function decomposition to the system and make the overall plan design. Secondly, the experiments start from the smallest system of the master control chip. The external functional unit circuit is gradually added. The circuit assembly and debugging of one or two functional units are completed in each experiment. Finally, all functions are completed through the system integration debugging, so that the expected goal of the experiment was realized. The process of completing the design enables students to experience the process from zero foundation to introduction. On the basis of the above process, students can complete the design and development of simple applications. The purpose of the experiment is to enable students to understand the general process of embedded development, so as to lay a good foundation for further learning in the future. In this process, the teacher should constantly inspire students to think about the current shortcomings or innovation which can be done and guide students to think positively more "golden ideas".

Compared with the original experimental arrangement, the experiment content after the reform is increased. The participation of students is greatly increased, and the workload of tutors is also greatly increased. Since the number of students choosing the curriculum has decreased compared with that before the curriculum reform, this work is feasible.
Evaluation Method

The course has strengthened the assessment of students' learning process in terms of assessment methods [3]. The assessment results include two parts, namely, the usual score and the examination score:

Total Score = Usual Score \times 50\% + Examination Score \times 50\%
Usual Score = Attendance (5\% of the total score)
+ Answer Questions (5\% of the total score)
+ Homework (20\% of the total score)
+ Experiment (20\% of the total score);

Homework is submitted in the form of student work, focusing on knowledge application and practical operation.

The assessment method and score distribution instructions are shown in table 1.

<table>
<thead>
<tr>
<th>Performance</th>
<th>Assessment/Evaluation</th>
<th>Score</th>
<th>Assessment/Evaluation Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grades</td>
<td>Homework</td>
<td>20</td>
<td>According to the completion situation of students' scientific and technological work, students are mainly assessed on the application of knowledge and mastery of the course, which will be counted into the total score by 20%.</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td>20</td>
<td>According to accomplish experiments, students are mainly assessed on the practical operation of the learning content, which will be counted into the total score by 20%.</td>
</tr>
<tr>
<td></td>
<td>Answering questions &amp; attendance</td>
<td>10</td>
<td>Students are mainly assessed on mastery of the learning content and learning attitude, which will be counted into the total score by 10%.</td>
</tr>
<tr>
<td>The final exam</td>
<td>Final exam score</td>
<td>50</td>
<td>It mainly assesses students' mastery of the course objectives and is counted 50% of the exam score into the total score. The exam covers not only basic theories and principles, but also solution methods to experimental and practical problems.</td>
</tr>
</tbody>
</table>

Through the above reform and exploration of the curriculum construction, students are encouraged to think positively and be good at discovering. We encourage students to turn their creative ideas into concrete objects in the form of discipline competitions or student development projects. To guide students’ independent learning and self-learning, selection or recommend outstanding students to actively take part in "challenge cup" national college students' science and technology work competition, the national undergraduate electronic design competition, the national college students' intelligence car competition, China engineering robot competition will be done. These competitions and activities can open up students’ horizons, enhance the ability of solving practical problems and accumulate the basis of engineering experience.
Conclusion

Based on the education concept of innovation and entrepreneurship and the characteristics of embedded system design, this paper explores the teaching content, teaching mode, experimental design and evaluation methods in the embedded system design course. Through curriculum construction, we will strengthen curriculum teaching management, deepen curriculum teaching reform, improve curriculum teaching quality, combine professional characteristics and actively cultivate innovative and entrepreneurial talents, which can serve the national development strategy and economic and social development.

Acknowledgement

This research was financially supported by the Lanzhou Jiaotong University 2019 Innovation and Entrepreneurship Course Construction Project 2019CXCYKC13.

References

