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The Hardware Practice Courses Design for the Innovative Engineering Thinking

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Abstract: *The separation of theory and practice of hardware course is an important factor affecting students to improve their ability of solving complex engineering problems. A six-stage hardware practice course design method is proposed. From enterprise demand to project driven, the student's ability and motivation of self-learning and self-improvement are inspired. Then we can drive practice by competition and further meet social needs by participating in various high-level competitions. The student-centered, teacher-guide is the core of hardware practice course teaching. The value of learning can be reflected by student's self-created achievements and the ability of solving practical complex engineering problems can be improved.*

Keywords: *hardware practice course, engineering thinking, engineering education, student-centred*

1. Introduction

The college hardware practice courses, such as single chip microcomputer and embedded system, are the most important part of knowledge and ability in engineering education [1]. It is also the most important practical ability exercise for students before graduation design. Different from knowledge teaching courses, hardware practice courses need to completely give the initiative of learning to students, so that students can learn by doing, learn by thinking and summarize in practice. The traditional hardware practice courses in universities are divorced from reality. They often take the completion of tasks as the basic goal, which is not conducive to the cultivation of engineers' thinking [2].

A large number of teaching practice studies around the world show that under the guidance of STEM (Science, technology, engineering, Mathematics), integrating hardware equipment, various sensors and programming practice can effectively integrate into university practical education. Students can learn with problems, and can more effectively evaluate the teaching effect of practical ability [3-5].

As an important member of CDIO international cooperation organization, Beijing Institute of petrochemical technology has passed the Washington engineering education certification in many majors, deeply explored the talent training mode of hardware practice courses, actively promoted all-round teaching reform, and worked hard to build a practical teaching system focusing on the training of engineers and the ability to solve complex problems in practical engineering [6]. Focusing on hardware courses such as "Microcomputer Principle and interface technology", "single chip microcomputer engineering training" and "embedded system", it lays a solid foundation for students' graduation design and professional work in the future from knowledge transfer, experimental operation, comprehensive design to ability training.

2. Problems facing the hardware practice courses -A case study of single chip microcomputer

Single chip microcomputer engineering training is the core course of hardware courses. It is the connection course between microcomputer principle and interface technology and embedded system. It mainly introduces the development and application of single chip microcomputer, the internal structure of 51 single chip microcomputer, C51 language, etc. In practice, it includes basic language experiment, interface experiment and comprehensive design. The practical content is complicated, and it is necessary to master the use methods of a variety of chips.

However, in the process of practical teaching, we mainly face the following problems:

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(1) The understanding of hardware and the joint debugging of software and hardware are not enough, and the thinking training of hardware engineers is less;

(2) There is a lack of connection with the actual market demand. The ability to master tools is poor, and it is unable to use the learned knowledge to expand and master new knowledge;

(3) The evaluation mechanism is unreasonable, which cannot comprehensively assess students' hardware programming ability and software and hardware debugging ability, and there is little space for continuous improvement.

3. Teaching design method of hardware practice course

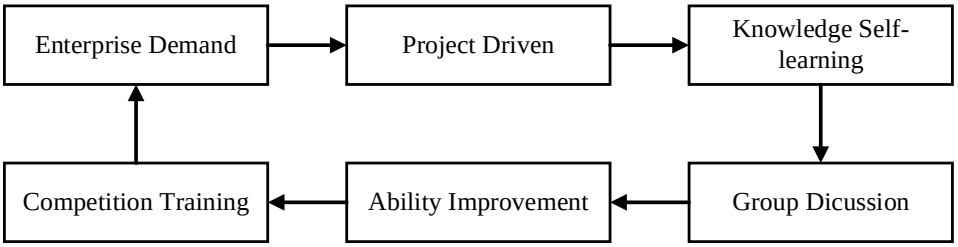

Figure 1: "Six-stage" hardware practice course design method.

3.1. From enterprise demand to project driven

The software and hardware engineers need to have a variety of abilities to solve complex practical problems, mainly including circuit design, signal conditioning, language programming, document writing, tool use, standard understanding and communication. They are highly professional and cover a wide range. Hardware practice courses have high requirements for the basic ability of students' prerequisite courses, and the curriculum design needs to be updated in time to keep up with the needs of enterprises, so that students can actively learn relevant knowledge, improve themselves and meet themselves [7].

With the rise of Internet of things technology and artificial intelligence, the demand for hardware practice has also been greatly expanded. Traditional responders, electronic clocks and traffic lights are regarded as classic cases with fixed thinking and single process, while smart home system, micro industrial control system, intelligent security platform, community access control system and remote monitoring system are regarded as emerging practical needs. It can be close to the reality of life and attract students' interest. The project design is more flexible for students to think deeply and improve the design.

3.2. From project design to knowledge self-learning

In the process of realizing the design purpose, the project design does not set specific implementation contents and experimental methods, and the students spontaneously look for solutions in the form of groups. The hardware equipment and programming language are no longer clearly specified. Combined with the virtual simulation technology and hardware platform, the self-formulation and implementation of multiple project topics are realized.

Knowledge self-learning follows the "three-stage learning method": problem proposal, solution, optimization and improvement, and then new problem proposal. The learning process here is completely completed and realized by the students in the group, and the teacher plays a more guiding and helping role. When the students' ideas deviate or have disputes, the teacher is responsible for solving the problems and returning the students to the normal.

In the process of knowledge self-learning, we should pay attention to methodology. Combined with the different characteristics of learning, such as hardware problems, software problems, debugging problems, it emphasizes divergent thinking, skillfully uses relevant tools, and actively looks for the optimal solution to the problem, which is called "open software and hardware collaborative thinking".

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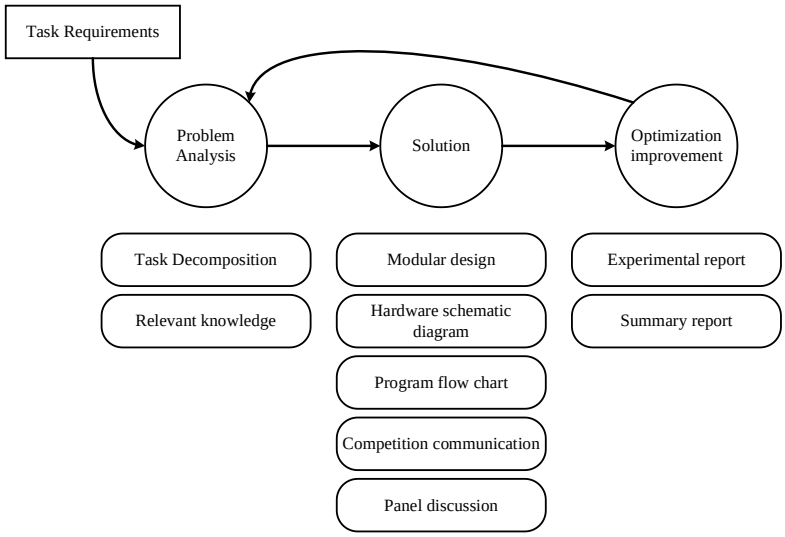

Figure 2: Three-stage learning method.

3.3. Promote learning through competition and comprehensively test the learning effect

"Promoting teaching through competition, learning through competition, reform through competition and construction through competition". Through the organic combination of "learning, training, practice and competition", it can pay attention to the cultivation of professional practical ability and professional quality of engineers, test the learning effect through competition. At the same time, through the participation of competition, it can learn from students in other countries around the world and improve themselves.

Taking part in the competition is a powerful supplement to the project design. At the same time, it can also test the effect of self-learning. After the competition, students need to summarize their study at this stage, find problems and put forward improvement measures. Through this cycle, students can find their own shortcomings and have inner motivation to improve their learning methods and learning contents.

4. Teaching evaluation method of hardware practice course

The curriculum needs to build a teaching evaluation system aiming at innovation ability and practical ability, and comprehensively assess students through the combination of teacher evaluation, students' self-report, intra group mutual evaluation, competition activity and other means.

The core of the evaluation includes five aspects: analyzing problems, solving ideas, operating ability, improvement measures and reporting norms. It focuses on the students' mastery of basic knowledge, the ability to summarize and analyze problems, and the ability of knowledge transfer and association. In general, it is the response ability and implementation measures of "curiosity", "adventure" and "challenge".

5. Conclusion

This paper puts forward the teaching design and teaching evaluation method of six stage hardware practice course. Starting with the problems faced by the course teaching, this paper focuses on the project design, knowledge self-learning, teaching design method of promoting learning through competition and the student-centered teaching evaluation system. It deepens the connotation of engineering education, effectively improves students' interest and initiative in participating in practice, cultivates students' thinking of hardware engineers, and stimulates students' desire and ability to innovate.

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