Analysis of Teaching and Effect of Project-Based Courses in Sino-Foreign Cooperative Education Major

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Abstract. In order to compensate for the lack of innovative awareness and practical ability of students in Sino-foreign cooperative education major, project-based courses are introduced in the training plan. This type of course refers to teaching philosophy and methods of the cooperative university, combines professional ability development with human resources and personal development, and cultivates students' innovative thought and practical capacity. These courses set the project as main content, and students find the solutions independently, conduct simulation verification and actual measurement. Through course study, students' professional practice ability of critical thinking and problem-solving has been trained and improved.

Keywords: Project-based course, Professional practice ability, Project Design and HRPD, Project Build and HRPD.

1 Introduction

School of Electronic Engineering, which belongs to Tianjin University of Technology and Education, has established a undergraduate education program with Atlantic Technological University of Ireland. For the major of Electronic Information Engineering, some reforms have been carried out in course setting and teaching content to solve the training problems, such as difficulty of theoretical knowledge comprehension, poor integration of teaching content with practice, etc. Referring to the course setting of cooperating University, project-based courses [1-4] are introduced in our training plan. These kinds of courses include "Project Design and HRPD" and "Project Build and HRPD" [5]. By learning from the teaching ideas and methods of cooperating university for such courses, we combine professional practice training with human resource and personal development (HRPD), aiming to cultivate students' innovative thinking and comprehensive abilities.

These courses are focused on projects. Teachers can specify the scope of project according to course requirements. The contents of projects can be determined by students. According to the project contents, students first consult relevant materials, make an execution plan, and accomplish software simulation. Then, students purchase necessary components and consumables, complete system fabrication and measurement. Finally, they must finish the research report. Teacher explains professional knowledge related to the project, resolves problems encountered by students. These courses cultivate students' abilities to think and solve problems, thereby improving their professional skills.

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2 Analysis of teaching content for project-based courses

2.1 Analysis of the "Project Design and HRPD" Course

In this course, students will design a project by themselves. The project is required to adopt a sensor to collect signal and display it using digital tube or LCD, and simulate the control process with a motor. In this course, students conceive and design a relatively complex system, complete hardware and software debugging, and achieve all functions of the system.

Background research and design of the project

Students design the system according to their own interests. They are required to conduct background research of the project in the first week, clarify the content of designed system, and draw a block diagram of it. In the second week, each student will present his or her project content and block diagram, and teacher give some comments and suggestions. The project content is determined at the end of this week. Students are advised to write the research content and work plan. For example, block diagram of an ambient temperature acquisition and control system designed by a student is shown in Figure 1.

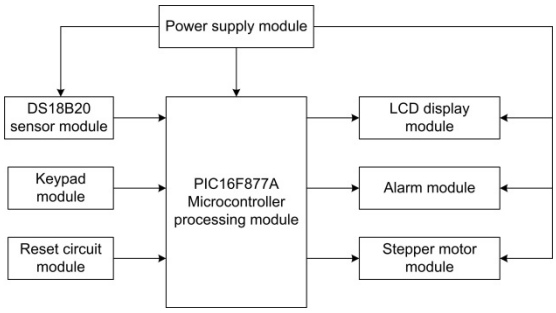


Figure. 1. Block diagram of an ambient temperature acquisition and control system designed by a student

Component selection and simulation of the system

Students are required to select necessary components for the system. They have to use Proteus to draw the schematic and make simulation verification. Teacher teaches some technical knowledge synchronously, including application of LCD, button control, analog-to-digital conversion, motor control, serial communication, etc. These contents can help students to accomplish circuit design and programming. A schematic of the ambient temperature acquisition and control system designed by a student is presented in Figure 2.

Circuit design and programming of the system

Students use HJ-5G development board of Huijing to design the system. Teacher explains the principle of PIC16F877A microcontroller and each component of the board. The sensor module and motor control module can be connected to PIC16F877A via Dupont wires. The display part (such as LCD, digital tube, etc.) can be connected to PIC16F877A with the expansion slot on the development board or Dupont wires.

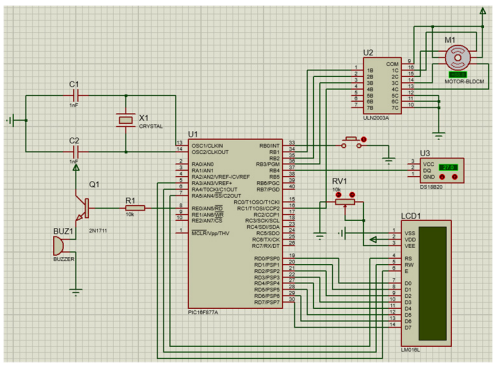


Figure. 2. Schematic of the ambient temperature acquisition and control system designed by a student

Teacher instructs students to make the circuit and program design. Students complete the debugging of circuit and program, and implement all the functions proposed in their systems. The photograph of ambient temperature acquisition and control system designed by a student is shown in Figure 3, and the corresponding program flowchart is decribed in Figure 4.

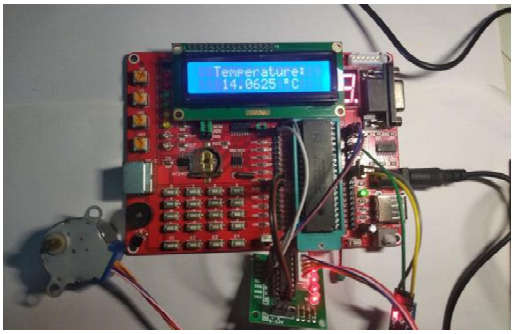


Figure. 3. The photograph of ambient temperature acquisition and control system designed by a student

At the end of the course, each student demonstrates the work and answers questions raised by the teacher. In the project report, students are required to elaborate on principle of the system, introduce the basic functions of HJ-5G development board, explain the circuit schematic and simulation results, the process of system fabricating and testing, and finally make a summary.

Specified tasks and HRPD

During the course, students should complete technical assignments related to the project design, such as motor control, PWM signal output, etc. According to the requirements of HRPD, the teacher will teach engineering ethics, personal habit formation, academic integrity and other aspects in class. Students write CV to enhance practical ability and social skills.

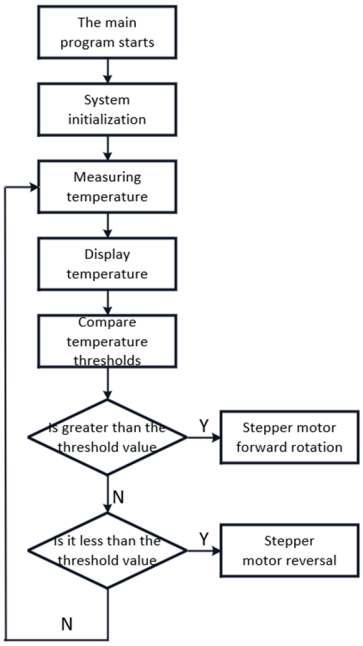


Figure. 4. Flowchart of the ambient temperature acquisition and control program designed by a student

2.2 Analysis of the "Project Build and HRPD" Course

During this course, students should expand the functions of the projects designed in "Project Design and HRPD". They are required to use Jialichuang EDA software to draw schematic of the circuit, make the PCB board, complete system debugging and achieve all functions. This course further cultivates students' practical ability to design complex circuit systems, and improves their software and hardware design level.

Further improvement of the overall project design

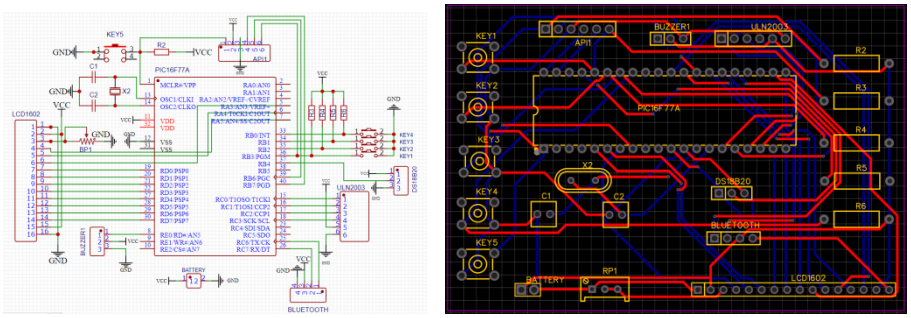
In this course, students will make further attempts to modify system structure and remake the circuit schematic. Based on the completed design, students add new functions (such as Bluetooth communication) to improve system application.

After improving the system, students are required to use Jialichuang EDA software to draw the circuit schematic. The components are arranged according to their actual requirements, and the PCB layout is generated. Discussions can be held between teachers and students to make necessary modifications until the PCB layout is determined. For example, the improved schematic of the ambient temperature acquisition and control system designed by a student is shown in Figure 5 (a), and the PCB layout is shown in Figure 5 (b).

System debugging and report writing

After the PCB board is fabricated, students assemble the circuit, complete the program debugging, and realize all functions of the system. The project report is required to rewrite, especially the composition of circuit schematic, which should be re-elaborated. The PCB

layout design should be added, and new functions of the system should be described in detail. The PCB board designed by a student is shown in Figure 6, and the photograph of the system is shown in Figure 7.



(a) (b)

Figure. 5. The improved ambient temperature acquisition and control system. (a) Schematic (b) PCB layout

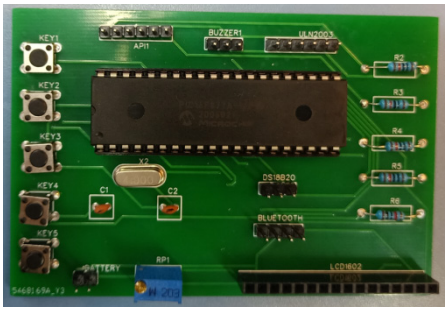


Figure. 6. PCB board of the improved ambient temperature acquisition and control system

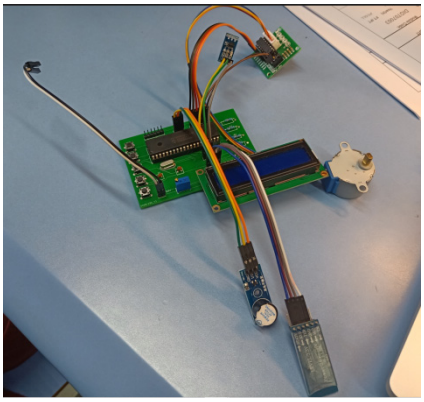


Figure. 7. Photograph of the improved ambient temperature acquisition and control system

In this course, the teacher supplements the content which is not teached in "Project Design and HRPD", such as Bluetooth communication, matrix keyboard control, etc. During the course, students also need to complete assigned homework, such as button-controlled LED, Bluetooth communication between mobile phone and PIC16F877A, etc. Through debugging of the system and writing of the project report, students' ability of identifying problems, thinking and solving problems has been further improved.

3 Comparative analysis with traditional teaching methods

As shown in the above analyses, the teaching methods of project-based courses can be considered as new approaches. Compared with traditional teaching methods, we take our traditional course of "Single chip microcontroller technology and application" for example. Teacher first explains the basic principles of the microcontroller, then teaches the internal resources (such as input/output interfaces, interrupts, timers/counters, serial interfaces, etc.), and next explain button control, digital tube/LCD display, analog-to-digital conversion, etc. Finally, students start to design the circuits and program. Such teaching methods and sequence of this curriculum make theoretical knowledge disconnected from practice. When students are required to design a control system with microcontroller independently, they have forgotten plenty of important knowledges learned before.

On the contrary, the teaching methods of project-based courses introduces the required content gradually during the students' project design, making it easier for students to understand relevant knowledge and improve their practical ability. These teaching methods emphasize the autonomy of learning, and have potential weaknesses in stimulating learning interest and motivation for some students lacking initiative in study. Since the project is proceeded, these issues of students will be gradually resolved during the course.

4 Survey and analysis of students' mastery

To verify the teaching efficiency of the courses, a questionnaire is set up to survey the students' learning condition. Students will answer some questions in four levels, namely completely master (CM), good master (GM), basically master (BM) and fail to master (FM). Forty-three students of Electronic Information Engineering from 2020 grade participate in this survey. Typical questions of the questionnaire are exhibited in Table 1.

Table 1. Survey questions for project-based courses

Serial Number	Questions
1	According to the project content, consult relevant references.
2	Be familiar with the peripheral circuit, such as button, digital tube, LCD, motor driver, etc. Able to use the development board for project design.
3	Draw circuit schematic and PCB layout with Jialichuang EDA software.
4	Able to write the content of the project report in English.

For question 1, the answer distribution of students is shown in Figure 8. It can be seen that the percent of student who choose CM, GM, BM, and FM is 35%, 39%, 26%, 0%, respectively. Most students believe that they have master the basic methods of consulting references.

Through classroom teaching, students' ability of consulting and reading English literature should be further improved by the teacher.

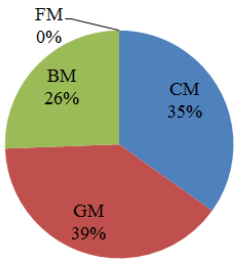


Figure. 8. The distribution of students' answer for question 1

As shown in Figure 9, the result of question 2 is presented as a pie chart. 79% of the students believe that they have a good grasp of the development board for project design. The courses have enabled students to master the basic methods of circuit design and system construction. After these courses, students need to further improve their project design skills in future learning and practice.

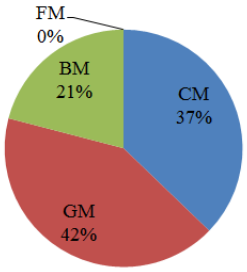


Figure. 9. The distribution of students' answer for question 2

The students' answer distribution of question 3 is exhibited in Figure 10. 77% of the students believe that they have a good command of Jialichuang EDA software to make circuit schematic and PCB layout. Drawing PCB board is an essential skill for undergraduate students. They should practice diligently and constantly improve drawing skills to meet the needs of future work.

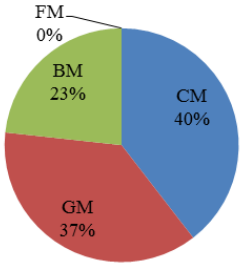


Figure. 10. The distribution of students' answer for question 3

For question 4, as described in Figure 11, most students have the English proficiency to write professional reports. However, 2% of students believe that they have not mastered this skill, mainly due to limited English writing competence. They need to supplement their English vocabulary and grammar seriously after class. English writing skills can only be gradually improved through continuous learning and practice.

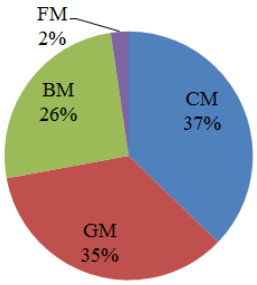


Figure. 11. The distribution of students' answer for question 4

5 Conclusion

The project-based courses adopt a gradual approach to cultivate students' professional practice abilities, and focus on the cultivation of engineering ethics and personal development. By learning these courses, students' abilities of discovering, thinking, and solving problems have been improved by themselves. Their practical operation skills and abilities of exploration and collaboration are enhanced and developed.

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