Journal of Education and Educational Research
ISSN: 2957-9465 | Vol. 9, No. 2, 2024

Research and Practice on Project Teaching of Electrical Control and PLC Course based on Engineering Innovation Ability Cultivation

Lingmei Ding *

Anhui Institute of Information Technology, Wuhu 241000, China
* **Corresponding author Email**: lmding2@iflytek.com

Abstract: In response to the wide knowledge coverage and strong practicality of the course "Electrical Control and PLC", this paper proposes a method to cultivate students' engineering innovation ability, explains how to use specific project-based course tasks as carriers, how to cultivate innovative thinking and abilities, how to combine teaching with practice, and finally uses the course design content as a specific example to demonstrate the practical teaching process in the classroom.

Keywords: Project Based Teaching; Innovative Engineering Skills; PLC Course; Teaching Reform.

1. Introduction

The course of Electrical Control and PLC is an important foundational course in the field of modern electrical engineering, aimed at cultivating students' theoretical and practical abilities in the field of electrical control. With the continuous progress of technology and the rapid development of industrial automation, electrical control technology, as a key force driving industrial transformation and upgrading, is increasingly widely used in various industries [1]. Therefore, teaching research and practice for this course are particularly important. In recent years, with the rapid development of information technology, intelligence, networking, and digitization have become the main development trends in the field of electrical control [2]. In this context, cultivating students' engineering innovation ability has become one of the important goals of electrical control and PLC course teaching. Engineering innovation ability is not only a necessary literacy for students to engage in electrical engineering related work in the future, but also a key driving force for promoting industry technological progress and development.

2. The Main Content of the Course "Electrical Control and PLC" Section Headings

Electrical Control and PLC is a core course that combines theory and practice for majors such as automation. It is an important course that cultivates students' learning ability, independent innovation ability, practical hands-on ability, and engineering application ability [3]. Through this course, students can initially establish a theoretical system of electrical control, master the basic principles, control methods, and technologies of classical electrical control and PLC control, and apply the learned knowledge to industrial automation control systems through further learning [4]. The course takes the relay contactor control method as the entry point, with a focus on PLC control. By integrating online teaching resources and subject competitions, it comprehensively analyzes the working principles of classic electrical control and PLC control schemes [5]. The course adopts project-based teaching, which strengthens students' project management through a complete set of processes such as project requirement analysis, scheme design, project implementation, project acceptance, and project report writing Engineering skills such as PLC application, software and hardware debugging, project document writing, and team collaboration. To lay the foundation for future professional challenge project courses, final design, and professional internships.

The course features include: 1. silently integrating ideological and political education into teaching at three levels: engineering literacy, scientific spirit, and strengthening the three values; 2. Adopting multiple teaching methods, teaching according to individual needs, emphasizing the stimulation of students' subjective initiative, and cultivating their critical thinking; 3. Emphasis on application and innovation: The course content is closely integrated with the practical needs of the industrial automation field, cultivating students' ability to solve practical problems and innovation awareness.

3. Cultivation of Engineering Innovation Ability in the Course of Electrical Control and PLC

3.1 Teaching Reform based on Actual Engineering Project Tasks

In response to the traditional "Electrical Control and PLC" course, which has more theoretical class hours and less practical class hours, single teaching content, monotonous teaching activities and organization, few teaching evaluation dimensions, and cannot meet the needs of current application-oriented talent cultivation, it is detached from the engineering site and environment, resulting in many problems such as mismatch or disconnection between the application process of students and the teaching content [6]. Based on the school's vision of cultivating "industrial engineers and entrepreneurial entrepreneurs" and the educational philosophy of "thick foundation, heavy practice, and strong application", the "Electrical Control and PLC" course is reformed accordingly. At present, the reform measures for the course of Electrical Control and PLC are as follows:

1. Optimize and upgrade the course teaching content, and reconfigure the theoretical and practical teaching hours.

In the context of modern intelligent manufacturing, the traditional teaching method of lecture and verification has been reformed into a teaching method that combines project teaching and project training. Group discussions and teamwork are adopted to cultivate students' team spirit. Adopting the concept of "project-based teaching" and guided by engineering applications, the course content is organized and implemented through "project tasks" on multiple enterprise production sites. The reform approach is to "learn by doing, learn by doing". The arrangement of teaching content is shown in Figure 1.

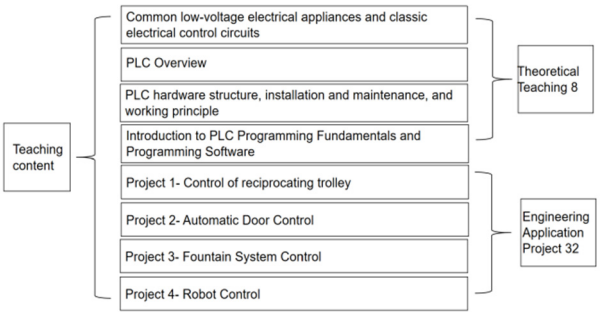


Figure 1. Course content arrangement

2. Upgrading teaching philosophy and implementing multiple measures simultaneously

Upgrading teaching philosophy and implementing multiple measures simultaneously is an important measure to improve teaching quality and an important guarantee for cultivating future engineers in project-based teaching [7]. The team continuously updates educational concepts during the process of education and teaching, and summarizes the following points.

(1) Project design leads teaching. Project-based learning reform, student-centered, explores student potential, and requires students to consolidate old knowledge and explore new knowledge in the process of project practice. Realize the correlation and iteration of new and old knowledge.

(2) Integrating ideological and political concepts into teaching. Internalize the cultivation of virtue and talent in all aspects of teaching, adhere to the cultivation of industrial engineers, and make engineering awareness and craftsmanship spirit the core content, integrating them into the curriculum in a holistic, scientific, and orderly manner.

(3) Engineering feedback supports teaching. In the context of comprehensive engineering education, the introduction of enterprise engineering project cases and subject competition cases in teaching makes project-based teaching come to life.

(4) Technological innovation helps teaching. Implement the project using Botu fully integrated automation software and Siemens hardware equipment, and share teaching resources with the intelligent teaching platform - FIF and AIClassroom, making knowledge accessible for learning everywhere.

(5) Learning community, happy teaching. Guided by the cultivation of engineering innovation ability, heuristic teaching is applied to guide students in learning methods, resource acquisition, team collaboration, engineering thinking, and other aspects throughout the entire process of project implementation. Students are encouraged to learn independently, think independently, and experience the process, enabling them to gain a sense of achievement and happiness in problem-solving.

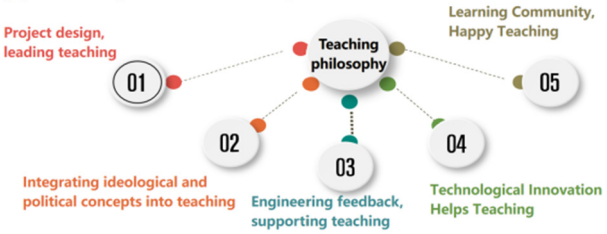


Figure 2. Teaching Concept of Electrical Control and PLC Course

3.2 Problem based Innovation Ability Cultivation

The course of Electrical Control and PLC needs to break the traditional course mode, no longer just focus on theoretical teaching and experimental verification, but transform into a combination of theoretical teaching and project teaching, highlighting engineering applications. Based on the experience of teachers in enterprise work and on-the-job training, from the perspective of engineering project implementation, and from the perspective of facilitating students to master core skills and increase employment competitiveness, we will transmit engineering and product awareness to students through course teaching activities [8]. In practical teaching, simplified engineering project cases are introduced, and the engineering development process and development ideas of each project are demonstrated and explained, guiding students to learn independently and innovate in practice from shallow to deep. Assist students in exploring the key tools and technical routes used in each stage of project implementation, laying a solid foundation in engineering practical skills while achieving close coupling with the establishment of other related professional courses.

(1) The "three based" teaching models, based on project requirements, team collaboration, and personalized student development needs, run through the entire course teaching activities.

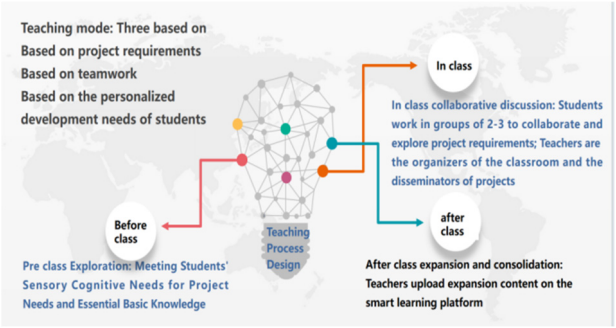


Figure 3. "Three Based" Course Teaching Models

(2) The teaching process of the course "Electrical Control and PLC", especially the practical stage, highlights and strengthens the engineering education concept of the course. The course selects 4 course project topics and 8 major homework project projects from enterprise practice and subject competitions, as shown in Figure 5, which are respectively the 21 level "Electrical Control and PLC" course project topics and extracurricular industrial application major homework projects.

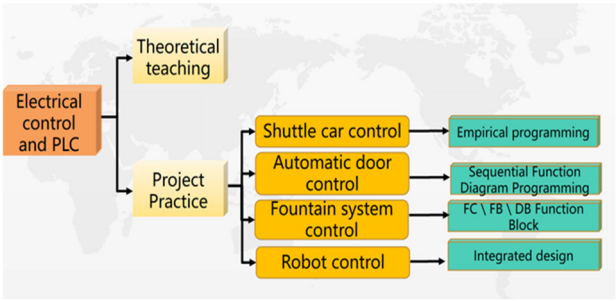


Figure 4. Project assignment

(3) This course has initially formed a distinctive teaching mode through careful design, which includes "theoretical preparation" → "basic training" → "advanced training" → "improvement training" → "comprehensive training" and "one preparation and four exercises". Horizontally enhance students' professional knowledge and project implementation skills, vertically cultivate their engineering literacy, and enhance their ability to comprehensively analyze, judge, and solve projects.

(4) The course project of Electrical Control and PLC simulates the production environment of multi-dimensional complex objects in industrial sites, and designs a project-based teaching plan driven by task challenges, reflecting workflow, and having a fast feedback mechanism. The project revolves around four project modules: requirement analysis, scheme design, project implementation, and acceptance and delivery. The PM (Project Module) implements a project teaching practice guided by the cultivation of engineering innovation ability. In the implementation of the project, the first party and second party models are simulated, emphasizing the need for continuous communication between needs and services, including clarification, argumentation, compromise, and innovation, to demonstrate the customer value oriented technology application of students under the promotion of cooperation and conflict.

4. Example of Course Practice Teaching

Electrical Control and PLC is carried out in a project-based manner and completed in small groups. The group members develop a project work plan and personnel division based on the project content of the introduction topic. The project practice aims to cultivate students' practical ability to connect theory with practice. During the project practice process, teachers provide full supervision and guidance, guiding students in all aspects of the project practice, implementing project-based teaching, including grouping, scheme confirmation, receiving components, software and hardware debugging, and project acceptance. Throughout the project implementation process, continuous feedback and modifications were made, which were ultimately reflected in the project report, as shown in Figure 5.

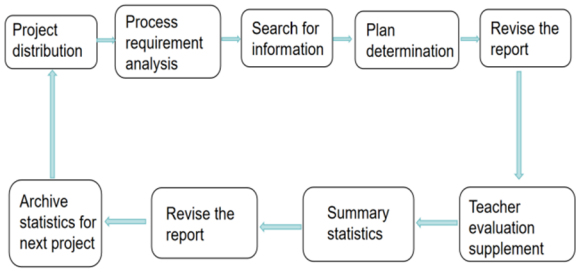


Figure 5. Teaching process

During the project implementation process, by collecting and reading relevant literature, find solutions to specific project related issues at different stages, and pay attention to environmental protection and sustainable development issues, and propose solutions; Design hardware circuits and software programs according to the plan, and correctly complete the comprehensive debugging of software and hardware integration to check the correctness of the system design; After the project is completed, write a design specification to cultivate students' ability to write scientific papers; Through the defense process, cultivate students' ability to write defense outlines and product descriptions, as well as their language expression and teamwork skills. Project practice has cultivated students' good project management awareness and improved their engineering practical abilities. Figure 6 shows the plan sharing and discussion process during the implementation of the student project, and Figure 7 shows the on-site defense of the teacher's acceptance project.



Figure 6. Project assignment



Figure 7. Acceptance defense

5. Conclusion

The author elaborates on how to cultivate students' engineering innovation ability from three aspects around the course of electrical control and PLC: firstly, teaching reform based on actual engineering project tasks, cultivating abilities through a complete development process; Secondly, problem oriented teaching can stimulate students' thinking and innovation; The third is to combine teaching with practice, using heuristic teaching, case analysis, and peer evaluation within the group for teaching. At the same time, the specific teaching process was described through teaching examples of demand changes. Practice has proven that the new teaching model can significantly improve the learning effectiveness of

students. Overall, the author has conducted beneficial discussions on how to improve the teaching of electrical control and PLC courses, cultivate students' innovation and practical abilities. In the future, we can further observe the actual effects of these teaching methods, supplement more teaching examples, continuously optimize teaching design, in order to form a mature and effective teaching system for electrical control and PLC courses.

Acknowledgments

This work is supported by the Anhui Provincial Department of Education's Provincial Quality Engineering Project "Project Electrical Control and PLC Teaching Innovation Team (2023cxtd124)" and "Automation Professional Transformation and Enhancement Project (2022 zygzts052)".

References

[1] Li Jing. Exploration of Teaching Reform in Electrical Control and PLC Technology Course [J]. New Course Teaching (Electronic Edition), 2023 (21): 171-172.

[2] Hu Xiaomei, Wang Ping, Diao Pengfei, et al. Teaching Reform and Practice of PLC Course Based on Applied Talent Training in the Context of New Engineering [J]. Paper Equipment and Materials, 2023,52 (11): 243-245.

[3] Chen Haiqin. Analysis of Teaching Plan Reform in the Course of PLC Programming Application [J]. Neijiang Technology, 2023,44 (11): 141-142.

[4] Shu Dandan, Wang Jinyuan, Shao Shuai, et al. Reform Measures for Electrical Control and PLC Curriculum [J]. Journal of Liaoning Normal University (Natural Science Edition), 2023,25 (03): 52-55+87.

[5] Liu Shunan. Exploration of PLC Course Reform in the Context of Intelligent Manufacturing [J]. Science and Technology Information, 2023,21 (08): 172-175.

[6] Chai Weihong, Li Guozhu, Yao Zimeng. Analysis and Exploration of Teaching Reform in Electrical Control and PLC Courses [J]. Electronic Components and Information Technology, 2022, 6 (12): 64-67.

[7] Wu Juqin. Curriculum Reform and Exploration of "Electrical Control and PLC" Based on Applied Talent Training [J]. Science and Technology Perspectives, 2022 (32): 95-97.

[8] Wang Jin, Han Chenxia, Wang Xiao. Exploration of Teaching Reform in the Course of Electrical Control and PLC Based on Online and Offline Integration [J]. Industry and Technology Forum, 2022, 21 (19): 163-165.