Advances in Educational Technology and Psychology (2025)
Clausius Scientific Press, Canada
DOI: 10.23977/aetp.2025.090518
ISSN 2371-9400 Vol. 9 Num. 5

Dual-Dimensional Collaborative Teaching Reform of Single-Chip Microcomputer Principles Course for Technology Empowerment and Value Leadership

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Keywords: Single-chip microcomputer principles; Ideological education; Technology Enablement; Craftsmanship spirit

Abstract: This study focuses on the Single-Chip Microcomputer Principles course for Electrical Engineering and Automation. The objective is to explore effective methodologies for the organic integration of technical education with ideological and political education. In the context of teaching practice, the deep integration of technology and ideological and political education is advanced from the key dimensions of the application of domestic chips and the cultivation of craftsmanship spirit. The teaching effectiveness was evaluated through a series of activities, including prominent competitions. To date, students have been awarded over 100 prizes at the provincial level and above. The research findings indicate that the practice scenarios developed by pocket labs have led to a substantial enhancement in students' awareness of technology ethics. Furthermore, the study has revealed that students have acquired a more profound comprehension of the ethical responsibilities and values associated with technology.

1. Introduction

As a fundamental measure to implement the task of fostering virtue and nurturing talent, the core essence of ideological and political education in courses lies in organically integrating ideological and political education into the teaching of professional courses [1]. This establishes a trinity education system of “knowledge imparting-ability development-value guidance”. The Single-Chip Microcomputer Principles course is a fundamental component of the curriculum in Electrical Engineering and Automation. The course material is notable for its substantial inclusion of ideological and political education resources. In the context of technological development, the domestication of single-chip microcomputers can be regarded as indicative of the ongoing endeavors of our nation to overcome the prevailing technical challenges. It is evident that a considerable number of researchers have, over time, surmounted a multitude of technical challenges, thereby attaining the ability to exercise independent control over single-chip microcomputer technology [2]. From the perspective of engineering practice, hardware design specifications and the process of program debugging embody the spirit of craftsmanship and the requirements of engineering ethics. The design of every circuit and the writing of every line of code require engineers to maintain a rigorous attitude and a high sense of responsibility to ensure the stability and reliability of the system [3].

The implementation of ideological and political education in engineering courses has exposed a number of urgent issues [4]. The most salient of these issues pertain to the accumulation of elements and the rigid implantation, the failure to thoroughly explore ideological and political elements in professional courses, and the neglect of the profound integration of professional characteristics and educational legislation. This approach has been demonstrated to be ineffective in achieving the intended objective of ideological and political education [5]. Furthermore, it has the potential to engender resistance among students, which may consequently have an adverse impact on the pursuit of professional courses. The integration of national strategic demands, industry technical standards and the curriculum knowledge system to establish a subtle ideological and political education mechanism has become a key issue that urgently needs to be addressed in the current construction of ideological and political education in engineering courses [6].

The present study adopts the reform of the Single-Chip Microcomputer Principles course as its point of departure. The reconstruction of teaching content, integrating domestic chip cases, facilitates student learning of professional knowledge whilst cultivating comprehension of China's current chip technology development status and challenges, thereby enhancing national pride and sense of responsibility. Innovation in practice mode is achieved through the execution of the pocket lab, fostering students' practical abilities and innovative spirit through subject competitions. Optimization of the evaluation system is attained by introducing process-based ideological and political assessment, enabling comprehensive and objective evaluation of students' ideological and political literacy and comprehensive ability.

2. Overview of the Single-Chip Microcomputer Principles Course

The Single-Chip Microcomputer Principles course content is centered on the MCS-51 single-chip microcomputer and systematically covers modules such as basic concepts, basic principles, hardware structure, instruction system, assembly language programming, interrupt system, timer, extension technology and single-chip microcomputer application technology [7]. Through a teaching design that combines theory with practice, students will master the core skills of software and hardware co-development of single-chip microcomputers, have the ability to design medium-scale application systems, and lay a solid foundation for subsequent professional courses. This course clearly meets the requirements for graduating from engineering education.

(1) The course helps students understand that there are many ways to solve complex problems in electrical engineering, and helps them find the right information in literature, databases and research.

(2) The course helps students to design systems, units (components), or processes that meet specific needs, and encourages them to think innovatively when designing solutions.

(3) The course helps students to learn how to use electrical instruments, tools, software and information data in the right way. This will help them to solve difficult engineering problems by analyzing them and understanding the limits of the methods used.

3. Case Studies of Ideological and Political Education

The fundamental objective of ideological and political education in courses is to cultivate students' sense of social responsibility, spirit of scientific and technological innovation, and patriotic feelings through course teaching. The following three cases are presented as illustrative examples of the integration of ideological and political education within a course-based curriculum, in conjunction with the technological development context of Single-chip Microcomputer Principles and the cultivation of a spirit of craftsmanship.

3.1 Case 1: The Rise of Domestic Chips and the Cultivation of a Sense of Mission

The examination will be conducted of the developmental history of single-chip microcomputers in conjunction with the developmental trajectory of China's chip industry. A systematic review of China's transition from reliance on imports to independent research and development will be undertaken. The objective of this review is to guide students in comprehending the competitive challenges and development opportunities of domestic chips in the global market.

The STC single-chip microcomputer can be used as a case study. This series of chips is a typical representative developed by domestic enterprises. In the early days, the industry confronted challenges such as foreign technological monopolies and restrictions on patents. It is evident that, over the course of several decades, the research and development team have gradually overcome a number of significant technical challenges. The aforementioned challenges primarily encompass the areas of low-power design, high-reliability processes, and instruction set compatibility.

The case offers students a direct understanding of the strategic importance of technological autonomy, inspiring a sense of mission to contribute to the country's technological self-reliance. The practical application of the STC single-chip microcomputer in the context of project-based learning provides students with the opportunity to experience the performance characteristics of domestic chips during the debugging process. This immersive approach is designed to enhance students' understanding of technological autonomy and controllability. By addressing real-world problems such as minimum system design and timer development, students can develop a deeper appreciation for the capabilities and limitations of these technologies.

3.2 Case 2: Craftsmanship and the Refinement of Technical Details

The Single-chip Microcomputer Principles course integrates the cultivation of craftsmanship into the detailed practice of hardware debugging and program optimization, guiding students from completing tasks to pursuing excellence.

In the hardware soldering session, students engage in repeated troubleshooting of problems such as false soldering and short circuits by constructing circuits for the STC89C52 development board. The objective of this exercise was to facilitate the students' intuitive recognition of the pivotal influence that circuit details exert on the stability of the system. In project practice, teachers request that students incorporate this spirit throughout the entire system design process. Evidently, students have achieved an enhancement in their overall performance, as demonstrated by an improvement in every technical detail, ranging from the selection and layout of hardware components to the structural optimization of software programmers and integrated debugging of system functions.

Through repeated practice, students gradually develop a professional conviction that meticulous attention to detail is pivotal in determining success or failure. They are able to transform technical awe into pragmatic actions to pursue excellence, and they establish a robust foundation for future complex engineering endeavors.

3.3 Case 3: Development of Practical Skills and Teamwork Skills

The subject competitions emerge as a pivotal medium for fostering students' practical capabilities and a sense of collaborative spirit. The organization of students to participate in national-level competitions, such as the LANQIAO Cup Single-Chip Microcomputer Competition and the National College Students' Electronic Design Contest, enables teachers to integrate the core knowledge points of the course with the demands of engineering practice. This integration process enables teachers to guide students in honing their technical skills and enhancing their teamwork awareness in real competition scenarios.

Within the context of the competition, students are required to engage in collaborative teamwork, with each team comprising three individuals. Each student is assigned a role, for example in hardware design, software programming, or document organization. Teachers facilitate students in overcoming technical challenges through a comprehensive guidance model that encompasses pre-competition simulation, process guidance, and post-competition review. It is imperative to cultivate students' sense of responsibility through the implementation of group tasks. It is imperative that these tasks encompass a requirement for each member to document their daily work progress and evaluate their peers. In the course of post-competition summaries, students should be organized to discuss how the results of the competition can serve society and guide them in transforming their technical skills into a sense of social responsibility to solve practical problems.

The students' participation in the competition engendered a number of notable developments. The most significant development was an improvement in their ability to work together to create software and hardware for single-chip microcomputers. Furthermore, the students cultivated a systematic approach to the resolution of engineering problems, whilst also acquiring competencies in communication, coordination and the distribution of responsibility within a team.

4. Reform for Course Assessment Methods

The key assessment points are closely aligned with the course's core objectives, encompassing three dimensions: an understanding of China's achievements in single-chip microcomputer development and the craftsman spirit, proficiency in program development, software application and principal practice, and hardware knowledge integrated with software design and debugging. This comprehensive approach aims to assess not only the mastery of knowledge, but also the application of skills and the cultivation of awareness. Table 1 presents the evaluation criteria for the Single-chip Microcomputer Principles course.

Table 1：The evaluation criteria for the Single-chip Microcomputer Principles course

Course objective	Assessment and evaluation methods (%)					
	Ideological Education	Homework	Practical skills	In-class test	Final Exam	Weight
1. The Evolution and Fundamental Concepts of Single-chip Microcomputer	2	7	1	7	15	32
2. Hardware Architecture and Assembly Programming Methods of Single-chip Microcomputer	2	6	2	7	20	37
3. Development Process of Single-chip Microcomputer	1	7	2	6	15	31
Total	5	20	5	20	50	100

The development of a three-dimensional assessment system, encompassing cognition, practice, and comprehensive application, integrating ideological and political education in courses, practical skills, and knowledge understanding, and the modification of the traditional single assessment model, is proposed. This approach aims to facilitate a more comprehensive and accurate evaluation of students' academic performance and ability growth, while concurrently guiding students to priorities industry development, refine practical skills, and deepen professional cognition.

5. Conclusions

The ideological and political reform practice of the Single-Chip Microcomputers Principles course demonstrates that the deep integration of engineering courses and ideological and political education can achieve dual goals: students acquire both solid technical skills and an enhanced sense of social responsibility and national mission. The course has been developed to combine the transmission of professional knowledge with the provision of guidance that is intended to be of value to the student. The result is a replicable model of ideological and political integration for engineering education. The utilization of science and technology to serve the nation should be prioritized, and robust support must be provided for the country's strategic technological development.

Acknowledgements

This work was supported by 2024 Undergraduate Course Ideological and Political Education Demonstration Course Development Project of University of Shanghai for Science and Technology (KCSZ202404).

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