

# Exploration of Teaching Reform of Single-Chip Microcomputer Course Based on Project Orientation and Innovation Ability Cultivation

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**Abstract:** This paper combines the reform and innovation in the teaching mode, teaching content, means and methods of the first batch of national excellent online open courses - Principles and Applications of Single-Chip Microcomputer of Jilin Institute of Chemical Technology, changes the traditional teaching methods, contents and means of Principles of Single-Chip Microcomputer, and realizes the innovation of the traditional course content and teaching methods. Integrate the emerging single-chip microcomputer technology, advanced typical application cases and problems into it, and combine the typical practical applications of single-chip microcomputers in China to enrich the teaching content of the course and increase the richness of the course content and the knowledge update rate. Strengthen project-based teaching and practical links, set up projects and tasks at different levels, and drive the effective combination of students' theory and practice based on projects to achieve effective training of students' theoretical foundation and engineering ability. Use single-chip microcomputers as the platform to carry out various teaching methods and means such as flipped classrooms and group cooperative learning to stimulate students' learning interest and self-study ability. Enable students to have the ability of autonomous learning and innovation; Establish a comprehensive evaluation system to assess students' mastery of knowledge and innovative achievements in all aspects. After years of reform and innovation construction and implementation, the students in the pilot class have significantly improved in various aspects such as independent thinking ability, hands-on practical ability and innovation ability. The successful experience of the reform of the single-chip microcomputer course can be used as a reference. It also provides a teaching approach and method suitable for the current educational model reform of the single-chip microcomputer course and some other engineering courses, which has certain promotion value for improving the quality of higher education in China.

**Keywords:** Blended First-class Undergraduate Courses; The Principle and Application of Single-Chip Microcomputer; Teaching Reform; Diversified Teaching Methods.

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## 1. Introduction

As the core component of embedded systems, single-chip microcomputers have indispensable application Spaces in fields such as industrial automation, intelligent control, and consumer electronics [1]. Due to the advancement of single-chip microcomputer technology and the continuous expansion of its application scope, a large demand for technical talents with a solid theoretical foundation in single-chip microcomputers and innovative capabilities has become prominent in society [2]. Therefore, as a part of the engineering education content, the quality of the single-chip microcomputer course has a direct impact on students' employment and the improvement of their scientific research level.

Blended teaching has received increasing attention in the wave of educational informatization in recent years [3]. Blended teaching, which fully integrates network technology and classroom teaching, can break away from the limitations of the original teaching framework and make teaching more flexible, time-saving and personalized [4]. The course "Principles and Applications of Single-Chip Microcomputer" of Jilin Institute of Chemical Technology has been approved as a national first-class blended undergraduate course, and significant achievements have been made in the teaching of the single-chip microcomputer course.

This paper conducts this research through the course "Principles and Applications of Single-Chip Microcomputer" of Jilin Institute of Chemical Technology, and deeply

understands the approaches, methods and effects of the teaching mode reform, content reconstruction, practical strengthening and student cultivation of this course. Through the research of this course, one can understand the realization of the value such as the application and development opportunities of this blended teaching mode in the single-chip microcomputer course, and provide reference for the reform research of this course in other colleges and universities [5]. At the same time, it is also hoped that this research can further promote the teaching reform of the single-chip microcomputer course. Cultivate more innovative single-chip microcomputer talents that meet the needs of The Times.

## 2. Theoretical Framework and Theoretical Basis

### 2.1. Theoretical Framework

The theoretical framework of the curriculum reform is based on the blended learning theory, the constructivist learning theory and the theory of cultivating innovation ability, jointly constructing the research system of the teaching reform of the single-chip microcomputer course, as shown in Figure 1.

Blended learning teaching theory: The blended learning theory refers to a teaching theory that combines online learning methods with traditional classroom teaching. It utilizes various information technology means to convert linear or nonlinear information, thereby integrating the advantages of informatization and networking to provide

learners with flexible and personalized learning methods and achieve the maximum learning effect [6]. In the teaching of the single-chip microcomputer course, the application of the blended learning teaching theory refers to self-study using online learning resources such as MOOCs and micro-lessons, and at the same time, combining offline and online classroom discussions and experimental practices to deeply understand the relevant contents of the single-chip microcomputer course.

**Constructivist view of learning:** Constructivism emphasizes that learning is a process in which learners actively construct knowledge rather than passively receive it. The application of the constructivist learning perspective in the teaching of single-chip microcomputer courses requires us to emphasize the subjectivity of students' learning in the teaching process, advocate that learners actively engage in the self-construction of knowledge during the learning process, cultivate students' knowledge innovation ability in a project-oriented form, and use the learning of specific tasks to complete the in-depth mastery of knowledge related to single-chip microcomputers.

**The theory of cultivating innovation ability:** Innovation ability is one of the requirements for talents in modern society. In the teaching process of single-chip microcomputers, based on the theory of cultivating innovation ability, we attach great importance to fostering students' innovative consciousness, spirit and ability. By introducing new technologies and new cases and setting more difficult project tasks, we stimulate students' desire and potential for innovation, and continuously carry out innovation in the process of continuous practical exploration.

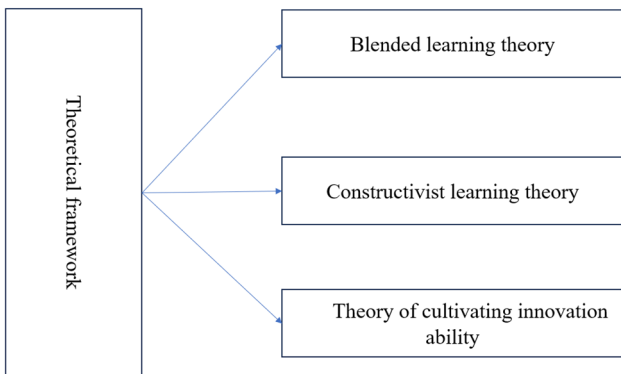


Fig 1. Theoretical framework diagram

## 2.2. Theoretical Basis

**Teaching psychology:** Teaching psychology is a powerful tool for teaching reform [7]. Teaching psychology emphasizes various factors that influence students' learning outcomes, such as learning motivation, learning style, and cognitive process. For the teaching of the single-chip microcomputer course, based on the principles of teaching psychology, we have developed course content and methods that conform to students' cognitive laws, to mobilize students' learning motivation and stimulate their enthusiasm for learning.

**Curriculum and Instruction Theory:** Curriculum and Instruction theory is a discipline that studies the laws and methods of curriculum development, curriculum implementation, and teaching activities [8]. Curriculum and Instruction Theory provides us with theoretical guidance in aspects such as curriculum design, teaching methods, and teaching evaluation. In the teaching reform of the single-chip microcomputer course, we draw on the achievements of Curriculum and Instruction Theory, optimize the curriculum

system, innovate teaching methods, improve the evaluation system, and enhance teaching quality and effectiveness.

**Information technology + Teaching:** With the rapid development of information technology, it has been more widely applied in education, and the deep integration of information technology and teaching has become a direction of educational reform. In the teaching process of the single-chip microcomputer course, we have utilized information technologies such as virtual simulation experiments and online collaboration platforms to provide students with more convenient and efficient support and services for teaching and learning.

The theoretical framework and theoretical basis of this article support and complement each other, jointly constituting the theoretical basis and support system for the research on the teaching reform of the single-chip microcomputer course.

## 3. Analysis of the Current Situation of Single-Chip Microcomputer Courses

As a professional basic course for related majors such as electronics and automatic control, the teaching quality of the single-chip microcomputer course will directly determine students' mastery of professional skills and career prospects in the future. However, there are still some problems and difficulties that need to be improved in the teaching process.

1. **Theory is disconnected from practice:** The traditional teaching of single-chip microcomputer courses mainly focuses on theoretical knowledge education, lacking a certain amount of time for students to practice. As a result, although students are proficient in the theoretical knowledge and programming of single-chip microcomputers, they are at a loss when facing the actual application process. Due to the disconnection between theory and practice, it has also dampened students' enthusiasm and initiative for learning the discipline of single-chip microcomputer, and restricted their innovative consciousness and problem-solving ability.

2. **Disconnection in teaching content:** Due to the rapid development of single-chip microcomputers, related technologies and new devices keep emerging. However, the teaching content of most single-chip microcomputers is still relatively backward, remaining at the classic level such as 8051 single-chip microcomputers, while there is relatively little learning content for emerging single-chip microcomputer technologies such as ARM and DSP. This makes the content students learn not match their needs and fails to meet the market demand for outstanding single-chip microcomputer talents.

3. **The teaching mode is too monotonous:** The traditional teaching of single-chip microcomputers mainly relies on imparting education. There is insufficient and inadequate interaction between teachers and students, and insufficient attention is paid to students' initiative and autonomy. However, relying solely on imparting education cannot effectively stimulate students' enthusiasm for learning and their subjective initiative. This makes it difficult for students to have good autonomy and team spirit when learning the single-chip microcomputer course. In addition, during the teaching period, the time is relatively tight. It is impossible to explain and guide all the questions and doubts raised by the students in one class, and thus it is difficult to achieve a more in-depth effect.

4. **Shortage of practical teaching resources:** The single-chip

microcomputer course places great emphasis on practical teaching and requires a large number of experimental equipment and corresponding experimental sites. Due to the insufficiency of conditions such as funds and venues, many colleges and universities have limited practical teaching resources. This will prevent students from getting sufficient practice to improve, which is not conducive to the cultivation of students' innovation ability and practical ability.

5. Absence of evaluation system: The traditional evaluation system for single-chip microcomputer courses mostly adopts a score system, which does not conduct a systematic assessment of students' practical ability, innovation ability and comprehensive quality cultivation. It does not provide a comprehensive reflection of students' learning outcomes and learning abilities, which is not conducive to the improvement of students' learning abilities.

The above problems urgently require the reform of the single-chip microcomputer course teaching. Through multiple aspects such as the reform of the curriculum system, content reform, method reform, strengthening the construction of practical teaching resources, and the reform of the evaluation system, the teaching quality of the single-chip microcomputer course can be improved, so as to better cultivate high-level single-chip microcomputer application technology talents with innovation ability and practical ability.

## **4. Teaching Reform of Single-Chip Microcomputer Course Based on Project Orientation**

In view of the current situation of the single-chip microcomputer course, such as the separation of teaching and practice, outdated teaching content, monotonous teaching methods, scarce practical teaching resources, and unscientific evaluation system, this paper focuses on how to establish a reform strategy for the teaching of the single-chip microcomputer course based on projects, with the expectation of cultivating students' strong practical ability, innovation ability and comprehensive ability in a project-driven way.

### **4.1. Reconstruction of the Curriculum System**

In view of the characteristics of single-chip microcomputers and under the guidance of the project-driven teaching concept, the curriculum system of single-chip microcomputers was readjusting first. Transform the single-chip microcomputer curriculum system centered on teaching knowledge points into a project-driven curriculum system. Organize the teaching process around actual engineering projects or application projects. Take projects as the main line of decomposition and integration, and interweave the basic concepts and principles, programming methods, circuit design, and debugging skills of the single-chip microcomputer course and other knowledge points into the project process. Students learn the working ability in single-chip microcomputer technology during the process of completing the project.

### **4.2. Optimization of Teaching Content**

Keep track of the development pace of technology, enrich the teaching content of single-chip microcomputers, and based on the classic content of single-chip microcomputers, while maintaining the basic content, integrate the knowledge of new-generation single-chip microcomputers such as ARM and DSP, enabling students to understand and master the

leading technology content in the industry. Combine practical applications with industry standards and norms to make the teaching content close to the market. Enhance students' employability.

### **4.3. Innovation in Teaching Methods**

The project-based teaching method is adopted to organize teaching. The teaching methods of lecturing, practice and discussion are closely connected. Students are fully guided and assisted during the project process. The enthusiasm and initiative of students in learning are stimulated by means such as guiding students to think and leading them to discuss with problems. Students are encouraged to enhance their autonomous learning and cooperative learning abilities through forms such as autonomous and cooperative learning. By applying new technological means such as virtual simulation experimental teaching platforms and mobile Internet, we can better provide convenient and fast conditions for students' practical teaching and make up for the deficiencies of practical teaching conditions.

### **4.4. Strengthening of Practical Teaching**

Further improve the practical teaching conditions, fully guarantee the experimental equipment and venues, and in the task design of the project, fully ensure that students gradually transition from completing simple basic experiments to completing multi-level and multi-dimensional project tasks such as comprehensive and innovative ones, cultivate students' practical ability and problem-solving ability, and while solving practical problems, Emphasis is placed on the cultivation and training of students' innovative abilities. Through cooperation and exchanges with enterprises and other means, enterprise experts are invited to provide guidance in teaching guidance and practical teaching environments.

### **4.5. The Evaluation System is Well-developed**

Improve the diversified evaluation methods, pay attention to the evaluation of students' learning process and ability, take summative evaluation as the main body, and evaluate students' project completion, experimental reports, teamwork, innovation ability and other various performances. Based on the evaluation data and results, give a relatively objective and fair evaluation of students' learning status, and conduct process evaluation and timely feedback. Guide students to self-correct and promote healthy development.

The teaching reform model of the single-chip microcomputer course based on project-based teaching is to reconstruct the course system, course content, teaching methods, practical teaching, evaluation system, etc. of the single-chip microcomputer course, improve the overall teaching quality and teaching effect of the single-chip microcomputer course, and cultivate more high-quality single-chip microcomputer technical talents with innovative spirit and ability.

## **5. Implementation Effect and Case Analysis**

### **5.1. Implementation Effect**

Since the implementation of the project-oriented teaching reform of the single-chip microcomputer course, we have achieved remarkable teaching effects and positive feedback. The following is a summary of the implementation effects in

several aspects:

(1) Students' practical abilities have been enhanced: Through the project-based teaching mode, students have achieved hands-on development, design and debugging of projects. In practice, they have gained a deeper understanding of single-chip microcomputer technology and mastered it more solidly. Their hands-on practical abilities and problem-solving skills have been significantly improved, and they can meet the actual requirements of engineering.

(2) Enhance learning interest and enthusiasm: The project-oriented teaching model has increased students' learning interest, initiative and enthusiasm. Through the training of carrying out projects, students can understand the practicality of the learned knowledge in the process of hands-on practice, thereby improving their absorption of knowledge. Meanwhile, the cooperative learning method of project groups enhances the awareness of teamwork and communication skills.

(3) Cultivation of innovation ability: In project work, by allowing students to innovate, try and explore, providing them with space for thinking and hands-on practice, enabling them to apply innovative thinking and innovation ability to design project plans, solve technical problems, etc., laying a foundation for their future employment.

(4) Enhance teaching quality and effectiveness: The reform of project-driven single-chip microcomputer teaching has enabled the course teaching of single-chip microcomputers to closely follow market demands and students' actual situations, thereby improving teaching quality and effectiveness. During the completion of the project, students not only mastered the core skills of single-chip microcomputer technology, but also had strong practical and innovative abilities, laying a solid foundation for their employment and further studies.

## 5.2. Case Analysis

Taking the teaching reform of the single-chip microcomputer course in Jilin Institute of Chemical Technology as an example, a case analysis of a typical project is selected for analysis. The "New Year Countdown System" is the design of a control system based on the combination of timer, digital tube and buzzer controlled by single-chip microcomputer. It is required to be able to realize the functions of displaying the New Year countdown every second and sounding the buzzer when the time is up.

(1) Project design and Practice: At the beginning of the project, the teacher introduces the project background, project goals and project requirements, and organizes students to conduct demand analysis and scheme design; After the students are divided into groups, they collect materials, design circuit diagrams, program design and debugging, etc. They also organize group discussions and project reports regularly, and the teachers provide timely guidance and assistance. Through continuous trial and error and debugging, students completed the design and implementation of the New Year's countdown system.

(2) Teaching effect evaluation: After the project is completed, a teaching effect evaluation will be conducted. Through the comparison of students before and after, as well as the comparison of students' learning situations before and after teaching, it is found that students' practical innovation and comprehensive quality have been improved. The evaluations of students were obtained through forms such as questionnaires and interviews. Most students affirmed the project-oriented teaching mode and showed high enthusiasm for students' learning interest and active learning.

## 6. Conclusion and Prospects

Through the implementation and effect evaluation of the teaching reform of the single-chip microcomputer course based on project orientation, we can clearly draw the following conclusions:

(1) The superiority of teaching methods: The project-based teaching method applied in the teaching of the single-chip microcomputer course can effectively overcome the drawbacks of traditional teaching, solve the problems caused by the separation of theory and practice, and significantly improve students' practical operation ability and creativity. In the participation of the project, students not only master the basic skills of single-chip microcomputer technology, but also learn how to use the knowledge they have learned to solve practical difficulties. Make full preparations for future employment.

(2) Enhance students' comprehensive qualities. The project-based teaching model not only requires students to master professional content, but also attaches great importance to the cultivation of students' cooperative ability, expression ability and innovative consciousness. By completing projects through group collaboration, students' comprehensive qualities are comprehensively enhanced, providing sufficient conditions for cultivating applied professional talents and fostering innovative and practical applied talents.

(3) The teaching quality has been significantly improved: With the application of the project-based teaching method, the teaching quality of the single-chip microcomputer course has been significantly enhanced. Students' subjective initiative in learning has increased, and teachers' enthusiasm and initiative in teaching reform have been greatly strengthened.

Looking forward to the future, the teaching reform of single-chip microcomputer courses based on project orientation still has broad development space and prospects. The following is our outlook for future work:

(1) The curriculum is constantly being improved. The maturation of single-chip microcomputer technology will take a long time. Our research group will also continuously improve the course Settings, add some of the latest technologies and application cases, to ensure the synchronization of technology and the industry, and to promptly understand the changes in students' learning needs, as well as to improve the teaching structure and content of the course, etc.

(2) Strengthen teaching models: On the basis of adhering to the project-based teaching model, more diversified teaching models should be adopted, such as introducing new teaching models like flipped classrooms, blended teaching, and project-based teaching. Improve the interactive communication and feedback system for classroom teaching.

(3) Strengthen the construction of practical teaching resources: Practical teaching is an inseparable and important part of the single-chip microcomputer course teaching. We will further strengthen the construction of practical teaching resources. By purchasing advanced experimental equipment and building a virtual simulation experiment platform, we will create a faster and more efficient teaching environment for students' practice. We will also enhance cooperation and communication with enterprises to jointly promote the optimization and upgrading of practical teaching resources.

(4) Develop multi-dimensional evaluation criteria: To reflect students' learning outcomes and abilities more

scientifically and objectively, and to avoid the traditional single-dimensional evaluation mainly based on test scores, we will continue to develop multi-dimensional evaluation standards. The multi-dimensional standards include students' completion of projects, writing of experimental reports, teamwork performance, and display of innovation capabilities, among other aspects.

In conclusion, the teaching reform of the project-oriented single-chip microcomputer course is of great significance. We will maintain an innovative and pragmatic spirit, continue to explore and summarize new teaching models and methods, and contribute to cultivating more high-quality technical talents in single-chip microcomputer with innovative spirit and practical ability.

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