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# Research on Teaching Reform of Principles and Applications of Microcontrollers Based on BOPPPS

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***Abstract:*** *In response to the call for the construction of first-class IoT professional courses and to promote the steady development of IoT engineering majors, a comprehensive teaching reform has been carried out on the principles and applications of Microcontrollers. The core goal of this reform is to cultivate students' comprehensive abilities. By introducing diversified teaching methods, students can not only master knowledge but also flexibly apply it to practice, achieving a transformation from knowledge learning to ability application. Through teaching practice, it has been verified that this teaching model significantly enhances students' interest in learning, while also greatly exercising their hands-on ability and innovative thinking. In accordance with the current requirements for engineering education professional certification, we have further introduced the BOPPPS teaching model and integrated and optimized teaching resources using the advanced online teaching platform "ChaoXing". Through the BOPPPS teaching model, we emphasize the subjectivity of students and increase their participation in teaching activities. This mode has the function of real-time learning situation analysis, allowing teachers to have a clear understanding of students' learning situation, and then reflect on teaching and adjust teaching content in a timely manner. In addition, we have also established a timely and effective closed-loop teaching feedback mechanism to ensure that every link in the teaching process can receive timely feedback and adjustments. This reform not only makes the course of Microcontrollers principles more in line with the needs of modern engineering education, but also lays a solid foundation for the development of the Internet of Things engineering major.*

***Keywords:*** *Internet of Things Engineering; Microcontrollers principles; BOPPPS*

## 1. Introduction

As the cornerstone of talent cultivation, the quality of courses plays a decisive role in the overall literacy of students. In response to the call of the Ministry of Education to comprehensively promote the construction of first-class undergraduate courses, we need to actively reform the curriculum concept, deeply promote curriculum reform, and eliminate inefficient and non substantial courses. Scientific, reasonable, and innovative teaching content not only reflects the forefront of the times, but also effectively ignites students' learning enthusiasm and guides them to increase their learning investment. Establishing efficient and high-quality classrooms is the key to cultivating high-quality and versatile new engineering talents with the spirit of the times. In the course system of Internet of Things engineering and related majors, "Principles and Applications of Microcontrollers" undoubtedly occupies a core position[1]. This course covers the rapidly developing technology in the field of modern electronic engineering. Mastering the design and application ability of Microcontrollers has become a basic skill for students majoring in Internet of Things engineering, and it is also an indispensable qualification for their future employment. From the follow-up courses of Internet of Things engineering, such as principles of automatic control, embedded systems, STM32 system development, to course design, graduation design, etc., all are closely related to Microcontrollers. However, due to the numerous concepts involved in this course and the relatively fragmented knowledge points, many students feel confused during the learning process, making it difficult to grasp the connections between knowledge points and practical application methods. This learning experience often leads to students losing interest in the course and learning more for the purpose of preparing for exams, which is far from the original intention of the course. Therefore, we need to re-examine and optimize the course of "Principles and Applications of Microcontrollers" to better meet the learning needs of students and help them grow into excellent engineering talents that meet the requirements of the times.

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## 2. The transformation of teaching concepts

In the context of the new era of Internet plus, traditional industries are experiencing deep integration with information and Internet platforms, promoting social and economic development into a new era. Especially in the education industry, the in-depth application of Internet technology has promoted the innovation of modern education technology, realized the sharing of high-quality teaching resources, and spawned cutting-edge teaching models such as online education and smart classroom. However, in the face of the urgent need to reform the teaching methods and methods in undergraduate education classrooms, we need to pay special attention to the long-standing phenomenon of "heavy research and light teaching" in some universities. In response to the call of the new era society for high-quality talent cultivation, we should deepen the reform of undergraduate education and teaching, and make every effort to create high-level courses with "high-level, innovative, and challenging" characteristics.

On the road to promoting the construction of first-class undergraduate courses, we must pay attention to the updating of teaching content. With the rapid development of electronic technology, Microcontrollers are evolving towards low voltage, large capacity, and high-performance, and are also moving from traditional industrial fields to intelligent manufacturing fields. To meet the demand for talent cultivation in new technologies, industries, and models, we need to take a series of measures to ensure that knowledge keeps up with the times.

Firstly, we need to abandon traditional teaching concepts and not only focus on theory as the core of teaching. We should combine textbook knowledge with extracurricular knowledge, and combine social production practice with social productivity. Continuously expand students' knowledge base through analogical learning. At the same time, we also need to enhance students' observation and thinking abilities, introduce engineering cases into the classroom, and enable students to improve their application skills in practice. Secondly, we should aim to cultivate students' practical application abilities and carry out the course of "Principles and Applications of Microcontrollers"[2]. Students not only need to master solid theoretical knowledge, but also pay attention to the development of cutting-edge technology, and bring practical application cases into the classroom for analysis. In this way, we can better cultivate students' thinking, exploration, and innovation abilities. Once again, we need to adjust the teaching mode and change the previous teaching mode where teachers give lectures and students passively receive. In the course of "Principles and Applications of Microcontrollers", teachers can first teach basic theories, and then have students group up to supplement practical application cases. This interactive teaching method can fully stimulate students' learning enthusiasm and potential, and establish a good teacher-student interaction atmosphere. Finally, we need to change the learning mindset of students who only focus on obtaining credits and taking exams. In terms of grade evaluation, we should flexibly set the proportion of final grades and no longer overly rely on test scores. Improve the proportion of daily performance in the total score, with daily performance mainly covering application case analysis, classroom interaction, homework completion, and other aspects. This evaluation method can more comprehensively reflect the learning status and ability improvement of students.

## 3. Classroom ideological and political education

In the teaching process of the course "Principles and Applications of Microcontrollers", we have closely focused on the practical and practical characteristics of the course, restructured the course content, and reformed the teaching methods. We are well aware that classroom teaching is an important "main channel" for ideological and political education. Therefore, we strive to cleverly integrate ideological and political elements such as the spirit of craftsmanship, model worker, labor, innovation, teamwork, technology for the country, national pride, self-confidence, and awareness of intellectual property protection into various aspects of the curriculum. The course team has carefully planned and designed the overall structure of the course based on product development ideas. Specially selected two core modules rich in technology and innovation elements - the design and production of smart transportation systems and the design and production of smart agricultural greenhouse control systems[3]. These two modules not only enable students to deeply understand and apply the principles of Microcontrollers, but also stimulate their patriotism, enhance their sense of national pride and mission through the development of high-tech products. At the same time, they cultivate their awareness of serving the country and building a strong technology country, as well as their craftsmanship spirit. In addition, we integrate ideological and political education into the teaching of professional courses through the promotion media of the great spirit. Through the completion of tasks,

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students can not only master professional knowledge, but also deeply appreciate the power of patriotism, perseverance, perseverance, and the spirit of national unity and solidarity in the fight against the epidemic. Through this teaching design, we aim to enable students to not only master the principles and application skills of Microcontrollers, but also elevate their thinking, becoming young people of the new era with noble character, innovative spirit, teamwork spirit, and social responsibility.

## 4. Classroom teaching strategies of BOPPPS

In today's society, Microcontrollers technology has demonstrated its indispensable importance with its wide range of applications, such as smart home appliances, industrial control, detection instruments, and network communication. Therefore, cultivating embedded application-oriented talents in Microcontrollers has extremely significant social significance and market value. In order to meet this demand, the course of Microcontrollers Principles and Applications is a compulsory course for students majoring in Internet of Things Engineering, and the innovation of its teaching methods is particularly important.

The traditional teaching mode of single-chip Microcontrollers is often teacher centered and textbook oriented, with experimental teaching only verifying and supplementing theoretical knowledge. Students often passively receive knowledge and lack opportunities for active thinking and practice, which to some extent limits the improvement of teaching effectiveness.

To improve this situation, we can introduce the BOPPPS teaching model. This model originated in the 1970s and was initially used in Canadian teacher skills training workshops. It is based on constructivism and communicative approach and focuses on students' active participation and immediate learning feedback. The BOPPPS teaching model divides classroom teaching into six closely connected stages:

(1)Bridge in: By introducing carefully designed scenarios such as stories and case studies, it stimulates students' curiosity and helps them establish connections between existing and new knowledge, laying a solid foundation for subsequent learning.

(2) Objective/Outcome: Clarify the learning objectives of the course, follow Bloom's educational goal classification theory, and ensure that students can meet the predetermined learning standards in the three fields of cognition, emotion, and motor skills.

(3) Pre assessment: Through online quizzes, questioning, and discussions, understand students' mastery of pre course knowledge and their level of previewing new knowledge, and help teachers adjust teaching content and progress.

(4)Participant Learning: Adopting diverse teaching methods such as group discussions, role-playing, and scenario simulations, it stimulates students' learning enthusiasm, enhances teacher-student interaction, and improves their classroom participation.

(5) Post assessment: Testing students' learning effectiveness through quizzes, answering questions, and demonstrating operations, providing immediate feedback on evaluation results, helping students understand their own learning situation, and encouraging teachers to reflect on teaching and adjust teaching design.

(6)Summary: With students as the main body, guide them to self summarize and share learning experiences, discuss together with teachers and students, emphasize key and difficult points, and provide reasonable learning suggestions. At the same time, assign homework and predict the content of the next course to ensure the continuity of knowledge and the continuity of learning.

The BOPPPS teaching mode provides a clear, organized, operable classroom teaching design scheme for the course of Microcontrollers principles and applications, emphasizing participation experience and teaching reflection. By implementing this mode, we can effectively improve students' learning interest and participation, improve the classroom teaching effect, and lay a solid foundation for cultivating embedded application talents of single-chip microcomputer. With the continuous integration of Internet technology into the education industry, modern education technology ushered in a golden age of rapid development. The construction of the "Smart Campus" network platform provides strong technical support and convenient conditions for school curriculum construction and teaching reform. In order to further improve the quality of course teaching and continuously improve the training path for professional talents, the course teaching team has carried out a series of in-depth teaching reform practices for the course of Microcontrollers principles and applications[4].

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Based on the core concept of OBE (Outcome Based Education), we have introduced the BOPPPS teaching model and combined it with the "ChaoXing" online teaching platform in smart campuses to jointly build a platform for sharing high-quality teaching resources. On this platform, we have uploaded rich teaching resources including PPT courseware, teaching videos, device manuals, and exercise banks, aiming to provide students with comprehensive and multi-dimensional learning support. In order to ensure the effective implementation of teaching reform, we have clarified the course objectives of Microcontrollers Principles and Applications based on the requirements of graduation achievement. In the teaching process, we always adhere to the teaching philosophy of "student-centered", stimulate students' learning interest through innovative teaching methods and means, and encourage them to actively participate in classroom teaching. Specifically, we adopted the BOPPPS teaching model, which divides the classroom teaching process into six stages: Bridge in, Objective setting, Pre assessment, Participatory Learning, Post assessment, and Summary. Through the introduction of this teaching model[5], we have carefully designed classroom teaching strategies to ensure that students can fully participate and deepen their learning at each stage.The implementation of this strategy not only effectively improves the effectiveness of classroom teaching, but also provides students with a higher quality and efficient learning experience.

## 5. Conclusions

In the current higher education environment, in order to cultivate first-class undergraduate courses and optimize the course structure, especially in the field of Internet of Things Engineering, we focus on the innovation of the Microcontrollers principle course. The traditional classroom teaching methods are gradually unable to adapt to the pursuit of ubiquitous learning and personalized learning in the new era. Therefore, we take the course of Microcontrollers principles as the breakthrough point for reform and are committed to cultivating applied engineering talents with practical operational abilities. In order to improve the quality of teaching, we have introduced the BOPPPS teaching model, which is an innovative teaching strategy. Through in-depth analysis of the six stages of the BOPPPS teaching model (introduction, objectives, pre-test, participatory learning, post test, and summary), we have designed a new teaching framework and applied it to the teaching of the principles and applications of Microcontrollers course. The practical results of this teaching reform are significant. The new teaching model truly embodies the educational philosophy of "student-centered" and greatly stimulates students' enthusiasm for learning. Through real-time feedback in the classroom, teachers can timely understand the learning status of students, reflect on teaching effectiveness, and flexibly adjust teaching content. Especially in the participatory learning stage, students shift from passive acceptance to active exploration, which not only enhances their critical thinking ability but also enhances their sense of teamwork. Comparing the data before and after the teaching reform, we found that students' course exam scores have significantly improved, and at the same time, the number of awards in various subject competitions has also increased significantly. These achievements fully demonstrate the effectiveness and practicality of the "ChaoXing+BOPPPS" teaching mode in the teaching of Microcontrollers principles courses. We firmly believe that this teaching model will provide strong support for the sustainable development of IoT engineering and other engineering majors.

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