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Teaching Reform of RFID Principles and Application Course with Information Industry Integration for System Capability Cultivation

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Abstract: The rapid development of the domestic information industry ecosystem has put forward higher requirements for the quality of computer talent training in colleges and universities. In response to the current issues of outdated course content and lagging teaching strategies in RFID principles and application courses at applied undergraduate institutions, measures have been proposed to promote the cultivation of talent for the autonomous and controllable RFID industry, taking the system capability as the main line. Under the guidance of the engineering education certification standards, based on the Tyler curriculum development model, domestic RFID platforms are introduced into the classroom. Through innovative reforms of the objectives, content, methods, and evaluation system of the RFID principles and application courses, the integration into the information industry ecosystem is actively promoted, enhancing the effective integration of the education chain, industry chain, innovation chain, and talent chain, contributing to the national strategy of independent control.

Keywords: System Capability; Information Industry Integration; RFID Principles and Application; Teaching Reform.

1. Introduction

With the shift in the global economic geopolitical center, some countries have imposed sanctions on China's information infrastructure. Core chips, basic hardware, RFID technology, data servers, and other information industries have successively encountered trade restrictions such as technology blockades, tariffs, and sanctions. Faced with the uncertainty of globalization, strengthening the autonomous control of the information industry is an important means to enhance international competitiveness. As the information industry innovates and upgrades, China's requirements for dynamic adjustment of the direction and field of talent training in colleges and universities are also increasing, and the cultivation of graduates' system capabilities is increasingly valued. RFID technology, as a key technology of the Internet of Things, manages the connection between the physical and digital worlds, occupying a basic and core position in intelligent systems. As one of the core technologies of intelligent systems, the domestication of RFID technology is both a demand for industrial transformation and a national strategic need. Domestic RFID technologies such as smart tags and readers have been launched, and various large-scale competitions and practical activities based on the RFID technology platform have also emerged. Under the support of these activities, universities are continuously promoting the educational and teaching reform of "system capability orientation."

Re-examining the domestic applied undergraduate RFID principles and application courses from the perspective of "system capability," the following problems in course construction are found: (1) The knowledge system is complex and abstract. The RFID course integrates multi-disciplinary knowledge such as electronic engineering, communication principles, and data structures. There are many theoretical concepts and abstract principles. Traditional teaching methods are not conducive to students' understanding of the RFID technology system; (2) The theory and practice are separated. Although the course has set up practical links, the connection between practice and theoretical knowledge is not high, and students' theoretical knowledge cannot be effectively transformed into practical skills, resulting in insufficient system application ability of students; (3) The teaching content is outdated. With the continuous innovation and development of the domestic information industry, RFID technology is constantly being updated, but the teaching content is out of step with the current state of technology evolution, and the existing curriculum lacks introduction to RFID system design methods, students' understanding of RFID technology is lagging, and they lack system design ability; (4) The intensity of the experimental content setting is not in place. The current experiments are mostly verification experiments, and there is little involvement in the deep practice of the core mechanism of the RFID system, which does not achieve a comprehensive practical effect, resulting in a general lack of system development ability among students.

This paper will be based on the dilemma of talent demand for RFID technology under the upgrade of the information industry, integrate domestic RFID technology into the RFID principles and application courses of colleges and universities, and discuss the integration of competition and teaching reform path based on the Tyler principle, in order to effectively cultivate students' computer system capabilities and promote the continuous and coordinated development of China's information industry.

2. Overview of Related Theories

2.1. Connotation of Computer System Capability

The concept of computer system capability originates from the 2013 International Curriculum Guide for Undergraduate Computing (Computing Curricula), referred to as CS2013. CS2013 is jointly written by the American ACM Association and the IEEE Computer (IEEE-CS) Association, reflecting the development and changes of the contemporary computer industry and the training needs for computer talents, which has played a strong role in promoting the undergraduate computer education of China and other countries internationally.

Compared with the previously released CS series (CS68, CS78, CS91, CS2008), CS2013 first proposed the importance of cultivating system capabilities, pointing out that the network economy era requires computer science students to have a "system perspective". That is, under the background of mastering the principles of computer structure, analyze the working principles of computer systems, be able to systematize the seemingly dispersed and abstract hardware and software knowledge, discover the laws between various elements of the system, and then find ways to solve complex engineering problems.

The computer system capability is specifically manifested in the cognitive ability, design ability, development ability, and application ability of the computer system. The system cognitive ability points to the cognition and understanding of the basic concepts of the computer system, and can analyze the relationship between hardware and software from the system perspective, aiming to help students establish a system view; the system design ability points to the design of the hardware system, software system, or the comprehensive system of hardware and software, emphasizing the optimization of the system; the system development ability points to the development and implementation of the information system, aiming to cultivate students' system development ability under the perspective of hardware and software collaboration; the system application ability points to the comprehensive application of the computer system, and can formulate scientific system usage, maintenance, and management plans according to actual scenes, environmental factors, and industry application needs, to ensure the long-term stable operation of the system.

2.2. Tyler's Rationale

Tyler's Rationale is widely recognized as the primary paradigm for curriculum inquiry in the West, encompassing classic curriculum and evaluation theories. It can guide the comprehensive reform and practice of this course from the very source. Tyler's curriculum development principles revolve around the curriculum objectives and pose four interlocking questions. By answering these four questions, the curriculum development process is decomposed into four closely related stages—determining curriculum objectives, selecting curriculum content, organizing curriculum forms, and evaluating curriculum effectiveness [16]. Tyler believed that curriculum objectives should point to "what students should do," meaning what skills students should master and what they should be able to do after learning the course, rather than simply memorizing course knowledge. The selection of curriculum content and the organization of the curriculum should be designed around the curriculum objectives, with the ultimate goal of achieving these objectives. Curriculum evaluation should point to "how to determine that these goals are being achieved," meaning that the purpose of evaluation is not to classify students but to focus on the quality of curriculum implementation and to optimize improvements to the curriculum, providing necessary guidance for the exploration of curriculum reform and practice in colleges and universities. Therefore, the evaluation methods of the curriculum should not be a single, terminal paper-and-pencil test at the end of the term, but should run through the entire teaching process, showing a diversified assessment approach.

Tyler's Rationale provides a universal curriculum development paradigm, and further exploration and reform can be made under this paradigm for the development of specific courses. Guided by Tyler's curriculum principles, the reform of RFID principles and application courses in applied undergraduate universities will start with curriculum objectives, establish the cultivation of system capabilities as the curriculum objectives of RFID principles and application courses, and select appropriate curriculum content around the objectives of system capability. The "capability-oriented" computer competition projects will be used as carriers to organize the curriculum form, and a multi-faceted evaluation closed-loop curriculum will be constructed to provide a driving force for cultivating independent and controllable operating system talents in China.

3. Curriculum Reform Path of RFID Principles and Application Courses

3.1. Establishment of Curriculum Objectives for RFID Principles and Application Courses

According to Tyler's Rationale, the establishment of curriculum objectives should come from three parties: students, life, and experts. Considering the training needs of applied undergraduate universities for talents who are autonomous and controllable in the information industry, this course adjusts life information to the RFID technology capability demand information of the Internet of Things industry, expert information comes from engineering education certification standards, and student information is related to students' knowledge reserves (prerequisite courses).

A survey was conducted on the RFID principles and application courses of computer-related majors in many applied undergraduate colleges in Guangdong Province. The RFID course is mostly arranged in the fifth semester, and students have already studied prerequisite knowledge such as basic electronic engineering, communication principles, and data structures.

The design of the curriculum objectives for the RFID principles and application course should be based on the Internet of Things system to determine the curriculum objectives of the RFID course. Table 1 divides the curriculum objectives into four categories: system cognition ability, design ability, development ability, and application ability, showing the setting of curriculum objectives for the RFID principles and application course oriented towards the cultivation of system capabilities.

The objective of system cognition ability is directed towards establishing a "system perspective," requiring the mastery of basic concepts of RFID technology in both software and hardware. The objective of system design ability is directed towards "system perspective" thinking, requiring the analysis of RFID design concepts and the interrelationship of hardware and software from an RFID system design perspective. The objective of system development ability is an extension and practice of the "system perspective," requiring the integration of basic knowledge of hardware and software with design ideas to achieve modifications and optimizations of RFID applications and systems. The objective of system application ability is directed towards methods of solving practical problems, requiring the analysis of comprehensive RFID applications in conjunction with application scenarios.

Table 1. Three Scheme comparing

Computer System Capability	Curriculum Objectives
System Cognition Ability	Curriculum Objective 1: To be able to describe the basic concepts, working principles, main components, and communication protocols of RFID technology, including tags, readers, antennas, etc.
	Curriculum Objective 2: To be able to analyze and resolve common issues and challenges in RFID systems, and conduct analysis on issues such as signal interference, data security, and privacy protection.
System Design Ability	Curriculum Objective 3: To design and plan a well-structured and modular RFID system from a design perspective, selecting appropriate hardware and software components based on requirements and design principles.
	Curriculum Objective 4: To integrate domestic and international RFID system design concepts and achieve secondary design of system architecture based on existing RFID technology.
System Development Ability	Curriculum Objective 5: To select and utilize RFID development tools, programming languages, debugging tools, etc., to develop the core functions of the RFID system.
	Curriculum Objective 6: To utilize the characteristics of existing RFID technology, analyze key system technologies, and write small-scale RFID application systems according to performance requirements.
System Application Ability	Curriculum Objective 7: To apply the principles and technologies of RFID to solve specific engineering problems in actual scenarios, such as intelligent logistics and smart retail.

3.2. Teaching Methods for the RFID Principles and Application Course

The restructured content system of the RFID Principles and Application course is composed of four major modules, each with different teaching focuses, course objectives, and corresponding system capabilities, thus requiring differentiated teaching methods. An innovative framework for teaching methods is designed to address the pain points of the RFID Principles and Application course: according to the role of each module in cultivating system capabilities, it is possible to consider interweaving and integrating the teaching content of multiple modules during the teaching process. While focusing on cultivating students' various system capabilities, it also encourages students to improve their "global perspective" thinking, enabling students to integrate the content of various modules when learning about operating systems.

3.2.1. Integrated Project-Driven Teaching Model

To help students build a complete system view of the RFID Principles and Application course and cultivate their system cognition and application capabilities, consider introducing the development needs of the information industry ecosystem under the "bottleneck" background. A large project that runs through the course—"Design and implement a mini-RFID reader system"—is used to connect the course content. Based on knowledge points, the course is divided into several small project tasks with different degrees of system capabilities, gradually cultivating students' computer system capabilities from simple to complex.

The RFID Principles and Application course deconstructs and reconstructs the complex and abstract knowledge, with the overall project of "Micro Operating System Design and Implementation." At the beginning of the course, the outcome target of the course is clarified, and students actively explore learning under the guidance of this overall project. At the same time, under the task-driven of each sub-project, the complex knowledge is integrated into a real project, helping students establish an overall vision of the system architecture. The difficulty of the first few projects in the project is relatively low, focusing on building students' system cognition. Later, it focuses on cultivating students' system design capabilities. In addition to needing to be familiar with knowledge such as process scheduling, allocation algorithms, and kernel working principles, students also need to understand the workflow and design ideas under different system architectures. The progressive sub-project-driven approach can better help solve the teaching pain points of the RFID Principles and Application course, such as "complex and abstruse knowledge system, and the separation of theory and practice."

3.2.2. Group Cooperation Flipped Classroom

The project-driven teaching model is carried out in the form of group cooperation to solve the pain points of "outdated teaching content" and "separation of theory and practice." After each sub-project teaching task is completed, the teacher reasonably creates a context based on the theme of the sub-project and conducts a thematic discussion-style flipped classroom teaching—uploading discussion materials before class (such as the discussion topic for sub-project two, "From the perspective of hardware storage architecture, analyze the innovation of domestic RFID reader systems"), and the group discusses the division of labor, consults materials, and makes PPTs according to the topic; during the class, guide students to send representatives to display and explain the PPT, express the group's views on the topic using the flipped classroom, and after the students share, the teacher continues to guide other groups to discuss and explore together; after class, students are required to continue to improve the PPT in conjunction with the classroom discussion and form a special topic report, which is uploaded to the learning platform as a special topic assignment. To this end, the teacher creates a set of "Operating System Thematic Discussion" resource library based on the sub-project theme, and the team of teachers can select appropriate discussion topics from the resource library according to the course teaching progress and student performance.

3.2.3. Learning and Teaching through Competition

The project-driven teaching model is a strategy for sorting out the entire course context and designing the course structure concept. The flipped classroom is a classroom teaching strategy for deepening and presenting the theoretical cognition ability of each sub-project. For some practical operation knowledge teaching and driving, it relies on the "learning and teaching through competition" approach for classroom teaching design and practice.

This course selects the practical competition of the Huawei ICT Competition - the computing track, with the competition as the core, and compares, analyzes, and combines the competition with the subject according to the 2023-2024 exam outline. Based on the standardization and practicality of the professional competition, it cultivates students' theoretical foundations and technical skills; integrates competition topics into teaching content, and decomposes teaching content, which is conducive to students' understanding and mastery of knowledge points, and also supplements the shortcomings of the textbook content that cannot keep up with the development of the times, enhancing the timeliness of teaching content. Through the openness and interest of the competition, it creates an efficient operating environment for students and effectively cultivates students' operating system development capabilities and application capabilities.

3.3. Evaluation Methods for the RFID Principles and Application Course

Traditional teaching content of the RFID Principles and Application course focuses mainly on the basic principles and concepts of operating systems, with final exam scores accounting for 80% of the course evaluation. Some students aim merely to cope with exams, failing to apply operating system theories to engineering practice, and are unable to improve their computer system capabilities through the course. Unlike the traditional final evaluation model of course evaluation, the RFID Principles and Application course evaluation system oriented towards cultivating system capabilities pays more attention to the effectiveness of students' computer system capability cultivation. It determines learning outcomes based on course objectives, and then designs evaluation methods according to teaching tasks, forming a corresponding relationship among course objectives, teaching activities, and course evaluations.

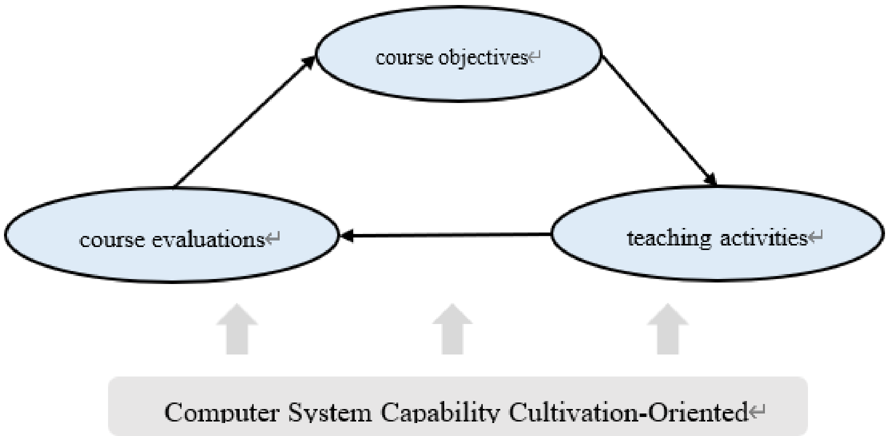

Fig 1. Reference Model for the Design of a System Capability-Oriented Course Evaluation System

Table 2. Overall Design of Course Teaching Evaluation

System Capability Objective	Course Objective	Evaluation Methods and Grading						Points
		Independent Study	Lab Experiment	Quizzes	Project Evaluation	Flipped Classroom	Final Exam/Competition Score	
System Cognition Ability	Objective 1	10		10	5		5	30
	Objective 2					5		5
System Design Ability	Objective 3			5	5	2	5	17
	Objective 4				5	3		8
System Development Ability	Objective 5		10				5	15
	Objective 6		5		5		3	13
System Application Ability	Objective 7		5		5		2	12
Total		10	20	15	25	10	20	100

Note: Competition results can replace final exam scores. Winning in the provincial preliminary of the Huawei ICT Competition's practical competition - computing track can replace 80% of the final score, and winning in the provincial final can replace 100% of the final score

The previous text has determined the four major categories of operating system capability objectives: system cognition ability, system design ability, system development ability, and system application ability. Each of the four system capability objectives points to seven specific course objectives, and the design of teaching content and teaching methods also revolves around the four types of system capabilities. Here, a diversified course evaluation scale will be constructed based on the reference model for the design of a system capability-oriented course evaluation system.

The evaluation of the RFID Principles and Application course runs through the entire learning activity process. The evaluation of system cognition ability corresponding to the course objectives accounts for 35%, system design ability 25%, system development ability 28%, and system application ability 12%, emphasizing the cultivation of various system capabilities. The course evaluation method reflects the continuous application and reform of the teaching method of the RFID Principles and Application course, adheres to the cultivation of system capabilities as the direction, and gradually achieves advanced goals step by step through diversified teaching modes such as project-driven, flipped classroom, and learning and teaching through competition. This evaluation scale helps to achieve "promoting learning and teaching through evaluation" and comprehensively promotes the achievement of course objectives.

4. Summary

System capability refers to the comprehensive abilities that students possess in the field of operating systems, including system cognition, design, development, and application. The RFID Principles and Application Course, oriented towards cultivating system capabilities and integrating information industry innovation, is based on Tyler's curriculum development theory. It is designed under the guidance of engineering education certification standards to meet the objectives of system capability cultivation. The curriculum teaching content is reconstructed in response to teaching pain points, adopting teaching model reforms such as competition-teaching integration, project-driven, and flipped classroom. The content is deconstructed and restructured to meet the goals set by the talent cultivation plan. The introduction of domestic operating system platforms into the classroom shifts the teaching content from international open-source framework platforms to domestically controllable framework platforms. This not only helps to promote the entry of the information industry ecosystem into campuses but also effectively cultivates students' computer system capabilities, enabling them to have the ability to solve complex problems and the capacity for innovative practice. In the future, we will further promote the reform of our school's RFID Principles and Application course design and domestic open-source experimental platforms, hoping to play an active role in cultivating reserve talents for the core technology and industrialization of China's RFID.

Acknowledgments

Research on Project Teaching Reform of RFID Principle and Application Course for Engineering Education + GKZL GC2023029.

References

[1] LV Haiping, Deng Honggang, Hua Xiangyu et al. Discussion on the coupling coordination effect between Higher Education and industrial development [J]. China University Science and Technology,2023, (06):73-80.

[2] Yin Shu, Zhang Yingdong. RFID Principle and application course teaching and system ability training [J]. Computer Education,2023, (03):90-93.

[3] Li Shanshan, Dong Wei, Luo Yu et al. Demand and practice of system Ability Training for Domestic operating system Research and Development [J]. Computer Engineering and Science,2018,40(S1):32-36.

[4] Xia Wen, Qiu Jieting, Chen Junjie et al. RFID Principle and Application course Exploration for autonomous and controllable talent training [J]. Computer Education, 2023, (02): 95-99.

[5] Shi Junyong, Liu Chaohui, Huang Yunzi. Research on the principle and Application of RFID in local undergraduate courses based on the integration of production and education [J]. Computer Knowledge and Technology, 2019,19(11):153-155.

[6] The Joint Task Force on Computing Curricula of ACM\IEEE. Computer Science Curricula 2013 Ironman Draft (Version 0.8) [EB/OL]. http://ai.stanford. edu/ users/ sahami/CS2013/, 2015-07-26.

[7] Zheng Weimin. System Ability training for Computer majors [J]. Chinese University Education,2021, (05):19-23.

[8] Qin Leihua, Tan Zhihu. Strengthen system ability and Promote the cultivation of autonomous and controllable talents in information industry [J]. China University Education, 2016, (07): 37-43.