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The Teaching Reform and Practical Research of "Internet of Things Technology and Application" in the Course System of Agricultural Electrification Major

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Abstract

With the development of network and information technology, agricultural electrification is gradually tending to networking, intelligentize and informatization development. For agricultural electrification major, based on the principle of "necessary and sufficient" and CDIO mode, analyze and study course contents, teaching methods and course assessment of the Internet of Things technology and application pointedly, the purpose is to improve students' engineering skills, deepen their understanding of agricultural electrification, and then develop students' systematic analysis and practical ability, which is different from the Internet of Things course of other majors, it can better meet the goals of agricultural electrification major training program, adapt to the development trend of modern agriculture and talent needs. It has been proved that the Internet of Things course using the CDIO teaching model has achieved good results in the teaching of agricultural electrification courses, and the professional knowledge and comprehensive quality of students have been improved.

Keywords: Agricultural Monitoring and Management System, Agricultural Electrification, CDIO Mode, Internet of Things.

1. Background

CDIO engineering education mode is the latest achievement of international engineering education reform in recent years. It provides a systematic teaching index and training system and pays attention to the relationship between professional knowledge and practical ability. From the current development and trend of world engineering education, increasingly complex engineering reality will be more closely integrated into the engineering education process [1-3]. China's engineering education is facing reform or transformation, some work shifts from idea to action. At the same time, with the rapid development of information technology and network technology, the trend of agricultural modernization and intelligent development is increasingly obvious. Internet of Things technology is bound to promote the rapid development of the agricultural industry. At the same time, Internet of Things courses and even Internet of Things engineering majors have been set up in related majors of various universities [4-5]. For example, the agricultural electrical major of Jiangsu University, this major has also been adjusted which add engineering technology courses such as “Internet of Things Technology and Application”. The emergence of the Internet of Things combines network technology, information technology, artificial intelligence and

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so on with all aspects of agriculture. It is required not only to be familiar with the theoretical knowledge of agricultural electrification, but also to master the principle and application of Internet of Things technology, be equipped with the analysis, design and implementation of Internet of Things technology and agricultural monitoring and management system, and promote the development of intelligent agriculture [6]. This is different from the course content of Internet of Things engineering major and other Internet of Things courses offered by information majors.

Based on this consideration, agricultural electrification major is more and more demanding. The original electrical and automation skills cannot meet the needs of high-tech and inter-disciplinary talents. The Agricultural Electrification in Jiangsu University was established in 1960 which based on agricultural machinery detection and control research direction of agricultural machinery design and manufacturing disciplines and the undergraduate major of agricultural electrification. At that time, it was one of the only two majors in China and one of the traditional dominant disciplines of Jiangsu University. After 50 years of construction, the discipline has made considerable progress and has become an important base for agricultural electrification, agricultural equipment automation research and talent training. Agricultural electrification became the second doctoral degree authorization point of this discipline in China in 2000. In 2001, it was named Jiangsu Province "eleventh Five-Year plan" key disciplines, again in 2006 was named the "eleventh Five-Year plan" key disciplines of Jiangsu province, in 2007 was named the national "eleventh Five-Year plan" key disciplines, in 2011 was named the superior subject of Universities in Jiangsu Province. Agricultural electrification is an interdisciplinary, comprehensive and applied major, which has a higher requirement for students' comprehensive practical ability. In the course system of agricultural electrification, it is found that many universities mainly divide the courses of agricultural electrification into two directions, one is the direction of agricultural electrification, the other is the direction of agricultural informatization. The curriculum setting of agricultural electrification is mainly aimed at agricultural strong power system, while agricultural informatization is mainly aimed at weak power system. These two kinds of courses are relatively independent in the curriculum system, with low correlation, to a certain extent prone to "hard and soft disconnect" [7]. Moreover, the homogenization of agricultural electrification in many universities is obvious and lacks characteristics. In the context of cultivating "Emerging Engineering Education", agricultural electrification not only focus on cultivating students' theoretical analysis ability, but also strengthen the cultivation of students' engineering capability and the improvement of their comprehensive application ability. On the other hand, many universities classify agricultural electrification as biological and mechanical colleges, which to some extent also limits the establishment and consolidation of engineering courses, resulting in the students' weak basic knowledge and insufficient practical ability [8-9].

Due to the current situation of agricultural electrification and the need of the development of the times, it is very important to use appropriate teaching mode to improve students' practice and professional development ability. Combined with the emerging Internet of Things information technology, this paper sets out from the concept of emerging engineering education, uses the "engineering problem solving mode", and follows the advanced (conceive-design-implement-operate) CDID mode [10]. For agricultural electrification curriculum system, introduce "Internet of Things Technology and Application" into agricultural electrification professional training system, so as to improve the intelligence of agriculture and engineering practice characteristics and meet the needs of agricultural electrification talents.

2. The course construction idea based on CDIO mode

"Internet of Things Technology and Application" is an information course. It involves many disciplines and specialties, its engineering technology characteristics are very typical and it has a wide range of application fields. Many universities offer the study and expansion of this course. Similarly, "Internet of Things Technology and Application" is also offered in the course system of agricultural electrification, which is an important part of this course system. By contrast, many universities have opened up agricultural automation technology, agricultural information technology and other courses. The course of Internet of Things technology is a course system that be applied to agricultural electrification later. On this basis, accomplish agricultural informatization, intelligence, modularization and integration, which is also an important way to cultivate students' practice and innovation ability. The course structure system of "Internet of Things Technology and Application" based on CDIO mode is set up in agricultural electrification major, integrate "Internet Plus" and "Intelligent Agriculture" of modern agriculture development, increase the practical application of agriculture, further improve the knowledge system of this course, and focus on the integrated cultivation of knowledge and ability. This also conforms to the important standards of CDIO teaching mode. Previous courses are independently set up according to the subject content, lacking the correlation between courses, so students cannot integrate knowledge and carry out practical activities. The content of "Internet of Things Technology and Application" must be close to the knowledge system of agricultural electrification. The knowledge structure of this course is shown in Figure 1.

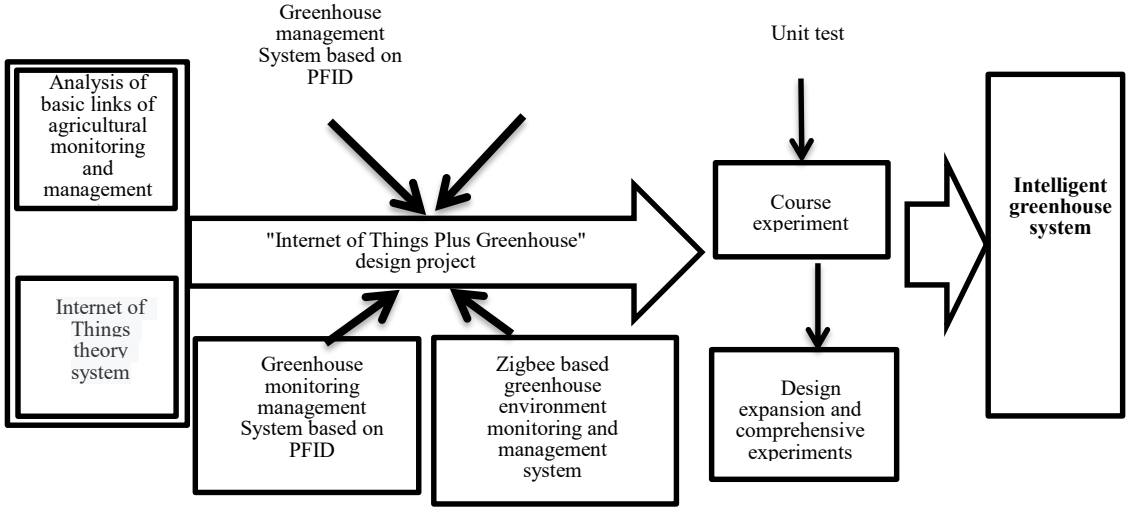

Fig.1. Knowledge structure of "Internet of Things Technology and Application"

2.1. Curriculum construction "C" stage - integration of teaching content, content determines form

In the CDIO education mode, stage C is the conception. Under the development environment of the agricultural industry, it is important to analyze the objectives and requirements of agricultural Internet of Things scene, define the functional and structural characteristics, integrate different modes information technology and engineering technology and carry out the reasonable construction of agricultural Internet of Things system and so on. Therefore, the "Internet of Things Technology and Application" that opened by agricultural electrification, its curriculum content mainly includes the function and structure of agriculture information basic link, the basic concept, development and theory system of the Internet of Things technology and so on. The goal is to monitor all kinds of agricultural and manage basic principle and structure of system, according to the functional requirements and the target demand of each link, add the different types of Internet of Things technology, design and develop a reasonable agricultural electrification

and automation projects, meet the agricultural operation process and make it more informationalized and more intelligent, focus on training students' ability to understand the functional requirements analysis of agricultural monitoring and management system and various information technologies of the Internet of Things [11-12].

Agricultural monitoring and management system mainly involves planting, harvesting, storage, transportation, packaging, processing and other links, which covers a wide range. Each agricultural link can be viewed as a subsystem that can operate independently. In view of different structure and functional requirements, the combination of agricultural planting and logistics with information technology and engineering technology is mainly considered in stage "C". In line with the principle of "necessary and sufficient", the ideological line is divided into three parts, which is the Internet of Things and runs through the theme of agriculture. The first part is the basic link analysis of agricultural monitoring and management system, the second part is the basic theory of the Internet of Things system, and the third part is the application of the Internet of Things in agriculture. Considering the vividness and comprehensibility of theoretical knowledge, we adopt case teaching method [13-14] to combine abstract theories with practical cases, so as to get rid of the traditional "spoon-feeding" theoretical teaching mode. Some details are shown in Table 1.

Tab.1. "Internet of Things Technology and Application"(Agricultural Electrification) theoretical teaching content design

Serial number	Name	Main content
first	Brief description of agricultural monitoring system	Functional analysis, structural composition, technical requirements and development trends of Agricultural monitoring (combined with greenhouse sensing Network case)
second	Brief introduction of agricultural control system	Functional analysis, structural composition, technical requirements and development trend of agricultural control (combined with greenhouse water and fertilizer control cases)
third	Internet of Things technology basics	The functional characteristics and technical analysis of the Internet of Things architecture and various information technologies
fourth	Application of Internet of Things technology in Agricultural Information System	Application and Analysis of various types of RFID technology, GPS technology, ZigBee technology and different network structures in agricultural information system (combined with the case of facility agriculture management)

This course’s important theory is basic theory and function of Internet of Things system architecture and network information technology. It uses case teaching method and hierarchical teaching method, takes agriculture greenhouse system as the research object and analyze which information network technologies are used in system design and construction in monitoring and management and the function of these Internet of Things technologies in relevant links. Then, we combine the actual object of the greenhouse, introduce a variety of fruits and vegetables to further analyze the performance characteristics and applicability of related Internet of Things technology.

2.2. The "D" stage of course construction -- functional analysis and scheme conception

The "D" stage of CDIO education mode is design practice. Through the cognition of facility agriculture, it can be integrated into the Internet of Things information technology according to the functional requirements of monitoring and management. This process covers the steps and methods of agricultural monitoring and management system planning and design, and applies engineering technical knowledge and

multidisciplinary design and so on to realize the practice of "Internet of Things Plus Agriculture". "Internet of Things Technology and Application" is agricultural electrification major students to learn the course, mainly monitoring and management at this stage, with the introduction of RFID, sensor, a variety of wire network, information management platform and so forth, improve agricultural electrification major students' application ability of the Internet of Things technology in the experimental project, cultivate students' ability to analyze and solve engineering problems. Through the division of labor and cooperation, students communicate with each other, and realize the integration of hardware knowledge and software knowledge system in agricultural electrification. Some details are shown in Table 2.

Tab.2. The experimental project design of "Internet of Things Technology and Application" (Agricultural Electrification)

Serial number	Name	Main content
first	Greenhouse crop monitoring system based on RFID	Technical characteristics and types of bar code; Characteristics, types and coding methods of RFID technology; Structure composition of regulatory system (Hardware and software construction)
second	Greenhouse environmental supervision system based on ZigBee	ZigBee technology features; Structure composition of regulatory system (Hardware and software construction)
third	Crop management system based on RFID	EPC electronic coding; Structure composition of regulatory system (Hardware and software construction)
fourth	Farm information location and management system	GPS technology features and function analysis; GIS technology characteristics and function analysis; Structure composition of regulatory system (Hardware and software construction)

For the monitoring of agricultural conditions and management subsystem, considering the characteristics of agricultural electrification, the content of each experimental project must not only satisfy the students' understanding of agricultural monitoring and management systems, but also use various information technologies to realize the functions of the system and achieve knowledge understanding and analysis in different disciplines.

2.3. The "I" stage of curriculum construction-professional integration, theory used in practice

The "I" stage in the CDIO teaching model is the implementation phase, and its main content is how to realize software and hardware integration, testing, and effective management in the process. This stage is based on the theoretical study in the "C" stage and the experimental project design in the "D" stage, and the experimental project is built according to the design ideas in the "D" stage. Some details are shown in Table 3.

This "I" stage focuses on the designated experimental project objects, and effectively builds to solve the engineering problems in actual facility agriculture. Taking the greenhouse system as an example, the experiment of the entire agricultural greenhouse system realizes the automatic monitoring process of greenhouse management through different information technologies and network technologies. Here, the facility agriculture monitoring and management system combined with Internet of Things technology is further subdivided. An experimental project focuses on learning the application of RFID radio frequency identification technology in facility agriculture, how to realize the reading and writing of RFID electronic tags, the electronic coding of fruits and vegetables, and finally through the actual modular connection to

realize the software and hardware experiments of the regulatory system. For example, in this experiment, I learned how to write, read, and use barcode technology.

Another experimental project is to learn the technical characteristics of ZigBee, realize the node self-organizing network function, and complete the supervision of the greenhouse environment. This stage has a very important role in cultivating students' practical application ability and analysis and problem solving ability, and further deepens the importance of Internet of Things technology in agricultural practical systems. At the same time, it also strengthens the students' teamwork ability and writing ability.

Tab.3. The experimental project of "Internet of Things Technology and Application" (Agricultural Electrification)

Serial number	Name	Main content
first	Greenhouse crop monitoring system based on RFID	Barcode reading and writing, RFID tag reading and writing, supervision system composition and upper and lower computer operation; Complete the experiment report
second	Greenhouse environmental supervision system based on ZigBee	ZigBee technology experiment, supervision system composition and upper and lower computer operation; Complete the experiment report
third	Crop management system based on RFID	EPC application design, RFID tag reading and writing, supervision system composition and upper and lower computer operation; Complete the experiment report
fourth	Farm information location and management system	GPS technology experiment, GIS technology experiment, supervision system composition and upper and lower computer operation; Complete the experiment report

2.4. Curriculum construction "O" stage-knowledge integration, deepening expansion

The "O" stage of the CDIO teaching model focuses on the rationality, convenience, and optimization of the experimental project. "Internet of Things Technology and Application" is mainly various types of network technology and information technology. Through the recognition and identification of various problems in the agricultural monitoring and management system, it is well expressed and analyzed to achieve the design goal. This method requires students to cooperate with each other to complete experimental design, systematic evaluation and experimental report based on the required knowledge in groups. Some details are shown in Table 4.

Tab.4. Analysis and Summary of the Experimental Projects of "Internet of Things Technology and Application" (Agricultural Electrification)

Serial number	Name	Main content
first	Analysis of experimental results	Analyze which IoT technologies are applied in the experiment and their applicability; Reliability, accuracy and timeliness of experimental items
second	Problem analysis of the experimental project	Analyze the design deficiencies in the experimental project
third	Expansion analysis of experimental project	Analyze the further upgrade of the experimental project in function and structure

Through the "O" stage, students can further realize the status of Internet of Things technology in agricultural monitoring and management systems. Then combine the demand of agricultural intelligence development, improve student's knowledge integration and system synthesis ability.

3. Teaching method reform based on CDIO model

The CDIO model is a teaching model for engineering education, and its main goal was to promote the further integration of theoretical knowledge and practical ability. Based on this concept, break the traditional teaching model, give the students the initiative to learn new knowledge, new content, and master new methods, guided by the teacher, led by the students, complete the study of entire course, and use the appropriate and flexible teaching methods according to the progress of the course.

3.1. Make use of online and offline resources to realize reverse classroom

With the spread of information technology and the continuous development of online teaching platforms, many teaching contents are put on the network for students to learn after class, forming a large number of online teaching resources. The course "Internet of Things Technology and Application" is taught in many colleges and universities, many enterprises outside the school are also developing Internet of Things products and related network resources are constantly updated in terms of content, form and other aspects. We should maximize the use of online resources as much as possible, and actively mobilize students' interest in the course. In terms of knowledge teaching, students are given basic knowledge points so that they can independently search for materials to learning before class, and organize various related activities in class to further sublimate and internalize the knowledge points, making it becomes a source power for students to continue learning. Through preview before class, actively participate in class discussions, and review and consolidate after class, the core network resources are turned into the main learning materials for flipped teaching, and the students' knowledge and learning ability are further expanded. The traditional classroom is gradually transformed into a flipped classroom.

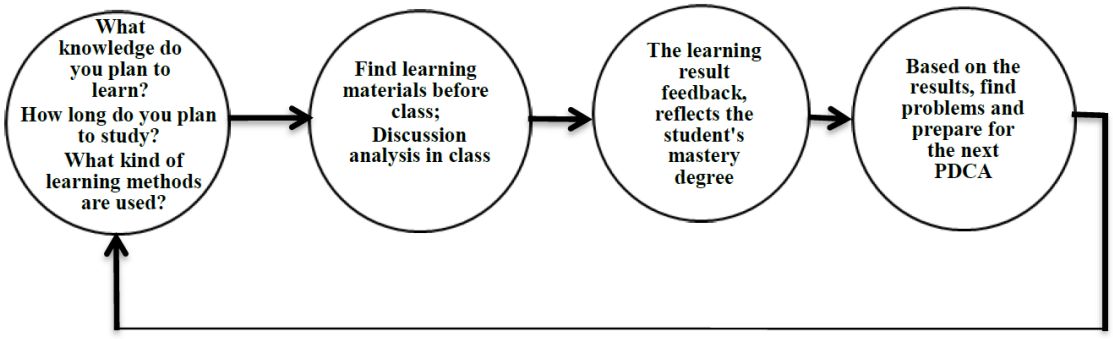

Fig. 4. PDCA-based "Internet of Things Technology and Application" learning process

3.2. PDCA step by step, perfect course teaching

Considering that flip teaching requires students to learn independently, teachers and students work closely together, and the PDCA cycle is used to manage the whole teaching process to improve course teaching. The PDCA cycle, which is P (Plan), D (Do), C (Check), and A (Act), is a practical method designed to achieve a better level through continuous improvement. This concept also has an important guiding role in course learning. The course "Internet of Things Technology and Application" is based on the framework structure of the Internet of Things, combing knowledge points from bottom to top according to the frame form to achieve top-down link. In the process of learning each knowledge point, I look forward to the next PDCA through the selection of learning content, the arrangement of learning progress, the

development of learning work and the reflection of learning effect, and even the combination of the new knowledge points and the feedback results. The process is shown in Figure 4.

With the help of PDCA, the classroom teaching is carried out purposefully and step by step, and the content of the course is studied point by point, so as to improve students' ability to understand the knowledge structure of the course.

3.3. Level teaching, from shallow to deep

The theoretical knowledge of the "Internet of Things Technology and Application" course involves sensors, networks, electromechanics, computers and so on. Compared with the courses offered by individual information majors, this course aims at the agricultural electrification majors, which naturally need to combine the characteristics of agricultural monitoring and management systems to establish their own unique course characteristics. Theoretical aspects follow the principle of necessary and sufficient, from basic knowledge to comprehensive knowledge, from general content to professional content, so that students can digest what they have learned in time and understand the connection and technical application of the functions of each link of the agricultural monitoring and management system. This makes the elusive knowledge in the book from simple to complex, from abstract to vivid, improve the teaching effect. For each experimental project in the curriculum provision, the experimental content and process are gradually expanded from a single point of experiment, then connected for modular combination and finally complete the whole experiment. Take the experimental project "Greenhouse Monitoring and Management System Based on RFID" as an example, which involves RFID electronic tags, scanners, information management systems, etc. This experiment needs to understand the overall process of the system and carefully design the experimental link around the knowledge points so that the students can choose the appropriate experimental content for the key knowledge points involved in this process, operate according to the experiment points, and then experiment layer by layer according to the process, finally complete the entire experiment. One of the knowledge points is to start from RFID tags, learn the coding of bar codes, low-frequency tags and UHF tags, then learn how the system scans RFID tags and recognizes the items identified by RFID tags. In addition, teachers need to express experimental rules to standardize students' experimental operations. Throughout the experiment, the teacher assumes the role of guidance, supervises the students' experiment process, urges the students to abide by the experiment rules, and sets a few small questions to guide students to think and analyze step by step: (1) What are the characteristics and application fields of various barcode technologies? (2) How to encode RFID tags and its size, capacity and so forth.

4. Course evaluation system based on CDIO model

Establishing a scientific curriculum assessment system is an important means to ensure the effective operation of curriculum and improve the quality of teaching. "Internet of Things Technology and Application" is aimed at agricultural electrification major, and establishes a curriculum teaching evaluation system from multiple angles of both the teaching and receiving parties and third parties.

4.1. Evaluation method of theoretical knowledge

Under the CDIO concept, the "result-based" assessment model is adjusted to form a student ability assessment model that emphasizes both "process" and "result". Traditional classroom teaching focuses on examination paper assessment, reflecting students' basic knowledge and personal understanding ability of course knowledge points. The usual theoretical teaching is based on the "cramming" teacher teaching

method. The theoretical content involves a wide range and is prone to fatigue. Adjust this way of one-way knowledge transfer, and encourage students to take the stage to deepen and expand theoretical knowledge with the help of topic discussions and special lectures. The process of teacher-student communication and student-student interaction achieves mutual promotion of teaching and learning. Through the process assessment not only reflects the students' understanding of the knowledge points of the course, but also demonstrates the students' comprehensive qualities, such as teamwork ability, engineering technology ability, system analysis ability and so on. Compared with blindly deciding course assessment based on paper-based scores, combined with process assessment, it reflects the overall mastery degree of students in this course.

4.2. Assessment method of experimental results

In the CDIO mode, "Internet of Things Technology and Application" sets relevant experimental projects according to the agricultural link (see Table 3). Adjust the experimental teaching and practical operation steps, and do not use the only set of assessment items for practical operation. This course follows from easy to difficult, from unit project to comprehensive project. The teacher sets basic goals and extended goals, customizes different tasks according to the goals, and allows students to choose hardware modules, code labels and use information management system platforms based on their understanding of the tasks, and finally shows different structures of the system. Throughout the experiment, supplemented by teacher guidance and designed mainly by students, students complete the combination of theory and practice from the study and application of basic principles. Students can also design such experimental links according to their mastery ability, avoiding the problems of "simplification" and "no cooperation". Through teamwork, it helps the student group improve its ability and further understand the actual operation of the Internet of Things technology and agricultural monitoring and management system.

4.3. Evaluation of teaching effect

Teaching effectiveness can be viewed according to the short-term and long-term process. The most direct short-term effect is the students’ final grade of the course for each semester. At this stage, this method is the most direct, but it cannot fully reflect the comprehensive ability of students to a certain extent. From a long-term perspective, it is necessary to consider guiding significance of the curriculum for students, whether it is conducive to students' ability development and the sustainable development of the curriculum. The course evaluation method mainly adopts questionnaires, seminars and anonymous grading, focusing on several aspects of course content, course learning method and course learning effect, and puts forward corresponding suggestions for improvement. At the same time, combined with the evaluation of the third party, through the supervision evaluation, employer feedback, etc. to help improve the theoretical knowledge and experimental project.

5. Conclusions

Guided by the CDIO theory, for the students of agricultural electrification, the CDIO teaching mode is introduced into the course "Internet of Things Technology and Application". According to the school's professional development features of "work-management integration, work-oriented", this course also gradually abandons the traditional classroom single-teaching model, taking into account the basic knowledge of the course and the cultivation of engineering practical ability, and following the principle of "necessary, enough" to realize the knowledge fusion of the Internet of Things system and the agricultural

monitoring and management system, and finally design the course content and evaluation method that are compatible with the agricultural electrification major and suitable for the CDIO teaching model. Through continuous course improvement, it has proved that students have been trained and improved in independent learning, teamwork, and hands-on practice and so forth.

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