Construction of Practical Teaching System for Internet of Things Specialty Based on New Business Orientation

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Abstract

The rapid development of Internet technology, the new business format promoted by Internet + industry technology, puts forward new requirements for talent specifications and capabilities, and corresponding reforms should be made in the talent training plan and training model. The practical teaching system is an important carrier for application capacity training and a reform the key of. Based on the OBE concept, a post capability survey was conducted for the Internet of Things major, and practical teaching goals were established based on post capability requirements, including: professional cognitive goals, professional technical goals, comprehensive application ability goals, entrepreneurship and innovation ability goals, analysis of ability elements and construction. The practice teaching system and the practice teaching evaluation system were introduced. Exploratory implementation of the 2018 and 2019 IoT majors. After third-party evaluation, the achievement of professional training goals has been significantly improved. The percentage of value-added of basic abilities is 93%, the percentage of value-added of professional literacy is 91%, the degree of professional recognition of students is 3.9 points, and the degree of professional maturity 3.8 points, the student satisfaction rate is 93%, the employer satisfaction rate is 93%, and the alumni satisfaction rate is 95%.

Keywords: *output-oriented, internet of things specialty, practical teaching body, construction, evaluation*

1. Introduction

The new technology revolution characterized by intelligence, big data, cloud computing, and Internet + has given birth to new business formats. In order to meet the demand for talents from new industries, new technologies, and new business formats, China has proposed the "new engineering education" action. Tianda Action Guide to Beijing, and actively explore the reform of engineering education [1, 2], meanwhile, the construction of first-class specialty has a guiding role in improving the level of personnel training [3]. In order to meet the requirements of the "new engineering education" reform, it is necessary to reform the professional training goals, graduation requirements, curriculum system, and training mode, and to be output-oriented, student-centered, and continuous improvement [4]. In application-oriented colleges, the cultivation of engineering and technical ability is an important training goal. Practical teaching is the main way to cultivate students' practical ability and innovative ability. [5] The achievement of the training goal of applied ability has an irreplaceable role and status. The professional application ability should be determined according to the professional requirements of the post group, and the professional core ability, special ability, and comprehensive ability should be analyzed, and the practical teaching content and practical teaching mode should be constructed accordingly.

For a long time, the content of our practical teaching has been almost completely in accordance with the professional standards specified by the country. This standard is a universal qualification standard. Application-oriented universities should refer to this standard while combining the school's positioning for running schools, highlighting the characteristics of engineering and technical capabilities [6]. Professional training positioning and graduation requirements are important manifestations of professional characteristics. According to the survey and analysis of job group capabilities, the construction of a practical teaching system is a professional continuous improvement important aspects. The practice teaching system refers to four parts including the goal system, content system, guarantee system and evaluation system of practice teaching. In order to achieve the training goal, we should plan and organize the practice teaching as a system, do a good job of the overall design, pay attention to the interconnection and effective connection of various practice links, and then embed it in the entire training system. At the same time, we should persist in taking the student as the center, and give full play to the student's main work in the practice teaching process [7].

2. IoT PROFESSIONAL JOB REQUIREMENTS

2.1 Talent Needs for New IoT Formats

Intelligentization, big data, and cloud computing promote the rapid development of the Internet of Things industry. The Internet of Things industry involves various application fields from sensors and controllers to cloud computing. There are many service industries and fields. Transportation and the Internet of Vehicles, intelligent logistics, and the consumer IoT industry are all key areas for the demand for IoT talent. The Internet of Things technology is developing rapidly, and the industry construction scale and technology level are at an unprecedented level. The Internet of things engineering design, engineering construction, maintenance, and services require a large number of technical personnel. According to Gartner estimates, the number of global IoT devices will reach 20.4 billion by 2020. HIS, a key information service provider of global industry information, predicts that the global IoT talent demand will reach more than 10 million in the next five years. At the end of 2018, the market size of the Internet of Things industry in China reached 1,360.3 billion yuan, and it will exceed 1.5 trillion yuan by 2020. The demand for professionals in the Internet of Things will increase rapidly. About 10,000 people. There are more than 1,000 colleges and universities in the Internet of Things specialty, and the number of graduates each year is less than 100,000, which is in short supply.

2.2 IoT Professional Competence Requirements

From the perspective of industrial needs, IoT talents can be divided into three categories: research talents, engineering application talents, and technical talents. Among them, engineering application-oriented talents are required to be able to engage in system design, product development, engineering project planning and implementation, including: RFID (radio frequency identification) system design and development, embedded software development, network installation and debugging, Internet of things hardware development, Development of sensor technology, marketing, technical support before and after sales. The demand for application-oriented talents in the implementation and maintenance of the Internet of Things industry has exceeded the demand for research-oriented talents. From the "New Occupation-Analysis of the Current Situation of the Employment Situation of IoT Installation and Commissioners" released by the Ministry of Human Resources and Social Security, the installation and commissioning of IoT The demand for staff is greatest, and this position requires technical staff to be proficient in operating IoT products, constructing IoT networks, and achieving "Internet of Things". Application-oriented schools should actively carry out practical teaching reforms, with graduates' post-oriented technical requirements as the end point, reverse construction of practical ability training systems, and strengthen the construction of practical teaching evaluation systems and guarantee systems.

3. CONSTRUCTION OF PRACTICAL TESTING SYSTEM

3.1 Orientation of Practical Teaching Goals

The goals of practical teaching include: professional cognitive goals, to enable students to correctly understand the role of the major in production, construction, management, and service. Professional technical goals, master the common techniques of the posts in the industry, meet the basic post requirements, and can use single or multiple technologies to solve practical problems in a practical environment. Comprehensive application ability objectives can comprehensively apply a variety of professional knowledge and professional skills to effectively solve complex engineering problems. The goal of innovation ability is to have the spirit of innovation, master scientific working methods and explore new knowledge and new technologies, and have strong innovation ability.

3.2 Construction of the Practical Content of the OBE Concept

3.2.1 Outcome-based Education

OBE (Outcome-based Education) education concept (output-oriented education) emerged in the United States in the 20th century. It is respected by engineering education in many countries and is an important quality criterion of the Washington Agreement. The OBE concept is based on the needs of technical positions in the industry, reversely designing educational content, formulating training programs and graduation requirements, and focusing on the achievement of the output (graduates) in the training process.

The training system of the OBE concept has to solve three problems. First, the demand for technical positions in the industry must be investigated and analyzed for job capacity requirements (including knowledge and abilities) under the conditions of the new industrial revolution in order to determine the training goals and graduation requirements. Second, what courses (including theoretical courses and practical teaching links) should be set up to support the training goals and graduation requirements. Third, how to ensure the achievement of the training goals and graduation requirements in the teaching process. For application-oriented universities, the construction of practical teaching links and the cultivation of practical ability play a decisive role in achieving the goal of talent training.

3.2.2 Analysis of Post Competence Elements

The export-oriented practice teaching system first focuses on job capacity research, analyzes and summarizes job capacity requirements, and forms a matrix of competency elements, as shown in Figure 1.

$$\text{Ai Post group}\begin{cases}\text{Comprehensive ability } A1\begin{cases}\text{Special ability } B1\{C11\cdots\cdots C1j\cdots\cdots C1m\}\\ \cdots\cdots\cdots\cdots\\ \text{Special ability } B2\{Ci1\cdots\cdots Cij\cdots\cdots Cim\}\\ \cdots\cdots\cdots\cdots\\ \text{Special ability } Bn\{Cn1\cdots\cdots Cnj\cdots\cdots Cnm\}\end{cases}\\ \cdots\cdots\cdots\cdots\\ \text{Comprehensive ability } Ai\\ \cdots\cdots\cdots\cdots\\ \text{Comprehensive ability } An\end{cases}$$

$$\text{Capability Factor Matrix}\quad C=\begin{bmatrix}C11\cdots\cdots C1j\cdots\cdots C1m\\ \cdots\cdots\cdots\vdots\cdots\cdots\cdots\\ Ci1\cdots\cdots Cij\cdots\cdots Cim\\ \cdots\cdots\cdots\cdots\cdots\cdots\\ Cn1\cdots\cdots Cnj\cdots\cdots Cnm\end{bmatrix},$$

Figure 1 Exploded View of Capability Elements

3.2.3 Construction of Practical Teaching Content

We can analyze the work technology point Eij corresponding to the ability element C, summarize and merge to obtain the practical teaching content array Fn, embed the post technical ability elements into the practical link, design the practical teaching content, and support the training goals and graduation requirements.

$$\text{Working Technology Point Matrix}\quad \begin{bmatrix}E11\cdots\cdots E1j\cdots\cdots E1m\\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\\ Ei1\cdots\cdots Eij\cdots\cdots Eim\\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\\ En1\cdots\cdots Enj\cdots\cdots Enm\end{bmatrix}\rightarrow\begin{bmatrix}F1\\ \cdots\\ Fi\\ \cdots\\ Fn\end{bmatrix}$$

Figure 2 Array of Practical Teaching Content

3.3 Practical Teaching Evaluation System

3.3.1 Internal Evaluation

Establish a practical teaching evaluation mechanism with

the characteristics of the Internet of things, including teaching evaluation and evaluation (evaluation) methods. Teaching evaluation content: random teaching file inspection, student symposium, and supervision and lectures. Evaluation content: Examine students' knowledge, ability and quality. The assessment of knowledge and ability focuses on the assessment of experimental skills, use of tools, engineering design and implementation, innovative thinking, ability to learn and solve problems. The assessment of quality is mainly based on the student's personal quality performance in the practice process, including personal character, professional quality, team spirit and professional ethics. Through internal evaluation, we fully understand the fulfillment of graduation requirements, systematically analyze the existing problems, and make continuous improvements.

3.3.2 External Evaluation

Establish a graduate tracking feedback and social evaluation mechanism, and use the evaluation results for continuous improvement. Establish graduate talent information database, regular graduate survey questionnaires every year, regularly issue survey forms to employers, and entrust third-party authoritative data agencies to conduct surveys and evaluations to analyze graduate levels. External evaluation is the highest level of OBE, and it is an authoritative evaluation of whether graduates have reached their training goals.

3.4 Practical Teaching Guarantee System

Practice teaching quality assurance system, based on PDCA management theory (Plan plan, Do implementation, Check check, Action processing). At present, we have researched more about training plan formulation Plan and teaching process Do. More emphasis is placed on the traditional teaching evaluation model, and the student's study is only a simple performance assessment. Check should be a comprehensive evaluation of the degree of achievement of the training goals in specific practice links, study the evaluation method and mechanism of the degree of achievement of the goals in practical teaching links, and develop effective improvement measures based on feedback from the situation.

4. IMPLEMENTATION EFFECT

The IoT specialty of our hospital is an application-oriented construction specialty in Tianjin. The training plan is based on the OBE concept. The graduation requirements include the following seven aspects: (1) Have a certain background knowledge of modern agriculture and understand the development trend of urban modern agricultural technology;) Grasp the basic theory and technology of agricultural information collection, transmission and processing; (3) Grasp the agricultural IoT system implementation technology and related design and development methods; (4) Have the basic ability of information organization, analysis, research, dissemination, development and utilization; (5) Possess a certain organizational management ability and strong written and oral expression ability, can be engaged in agricultural information technology promotion and training; (6) understand the development of relevant fields in this specialty, master document retrieval, data query, collection The basic method has a certain scientific research and practical work ability; (7) has a certain general foreign language and professional foreign language ability to meet the needs of outward-oriented regional economic development. The practical teaching system designed based on the research results is arranged for a total of 48 weeks, including 18 weeks of teaching practice, 30 weeks of curriculum design, practical training, and graduation design. Exploratory implementation in the 2018 and 2019 IoT majors, benefiting 120 people.

4.1 Induction of Job Capacity

The three core competency modules are the planning and design of the Internet of things system, network construction, installation and debugging of Internet of things equipment, and maintenance management of the Internet of things application system.

4.2 Induction of Ability Elements

Decompose the capability elements according to the three-layer architecture of the IoT system (sensing layer, transmission layer, and application layer). Perception layer: the ability to use information sensing equipment such as sensors, radio frequency identification (RFID) devices, infrared sensors, global positioning systems (GPS), and laser scanners. Transport layer: communication protocol, internet connection and technical capabilities for information exchange, communication, and resource sharing. Application layer: data storage, data processing, intelligent identification, positioning, tracking, monitoring and management technology capabilities.

4.3 Practical Teaching Content

Design practical teaching content based on competency elements, and embed each competence element into the corresponding practical teaching content, including experiments, curriculum design, comprehensive training, innovation training, and graduation design.

4.3.1 Experiment

Including the targeted selection of experimental content

such as Windows operating system, Office software use, electronic technology, analog circuits, digital circuits, radio frequency identification technology RFID, and sensor usage methods.

4.3.2 Course Design

Including C language programming, C language development, embedded programming, microcontroller design and application, PCB circuit schematic design, Java programming and other content choices.

4.3.3 Comprehensive Training, Innovation Training, Graduation Design

JSP application, Java programming, wireless sensor network technology ZigBee, WiFi and Bluetooth technology, wireless networking technology FPGA / CPLD development, Android mobile development case selection, IoT application engineering construction and maintenance.

4.4 Implementation Effect

According to a third-party survey (Mikes), the student's satisfaction with the practical teaching content setting reached 92.5%, which is higher than the average level of the entire school (83%), and the student's satisfaction with the practical teaching process reached 81.2%, which is higher than the average level (69%). The achievement of professional training goals has been significantly improved, with 93% of basic ability value added and 91% of professional literacy value added. The degree of professional recognition of the students is 3.9, and the degree of professional maturity is 3.8. The overall satisfaction rate of the graduates of the major (96%) is relatively high, of which 45% is very satisfied and 51% is satisfied. 45% of employers believe that the overall performance of their graduates is higher than the average level, and 53% of employers believe that the overall performance of their graduates is at an average level. The employment rate of the graduates of this major in 2019 is 96%, which is higher than that of similar institutions (92.7%).

5. CONCLUSION AND OUTLOOK

(1) For application-oriented universities, graduates' engineering practical ability is an important manifestation of the training level. The construction of a practical teaching training system based on the OBE concept must solve three problems. First, the industry's technical job requirements, research and analysis of job competence requirements (including knowledge and competence) under the new technology revolution, so as to determine the training goals and graduation requirements; practical teaching content; Third, the practical teaching evaluation system and guarantee system are important means to achieve the training goals and graduation requirements.
(2) Practical teaching training methods and models should reflect future work scenarios, and the practical links should truly reflect system design and development, embedded software development, network installation and debugging, and other work scenarios to achieve the "zero transition" of students from school to work. It is of great significance to the improvement of students' own competitiveness.
(3) The construction and implementation of the output-oriented practice teaching system has a positive effect on improving students' professional identity. The school-enterprise joint training mode has more direct contact with the working scene, and has an important role in improving engineering and technical capabilities and skills.
(4) The construction and training mode of practical teaching system should be continuously improved according to the development of new technology in the industry, and a tracking and feedback and social evaluation mechanism for graduates should be established. External evaluation is an authoritative evaluation of whether graduates have reached the training goal. The evaluation results should be used for continuous improvement, and continuously improve the quality of practical teaching and graduates.

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