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Research on the Teaching Reform of Radio-Frequency Identification Course Based on the Educational Philosophy of Outcome-Based Education

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Abstract: In order to improve the teaching effect and quality of the course Radio-Frequency Identification, we investigated the characteristics of the course and problems in its teaching practice. Based on the educational philosophy of outcome-based education (OBE), we carried out teaching reforms, which included the use of flipped classroom, the organic combination of theoretical and practical teaching, school-enterprise cooperation and collaborative education, as well as other measures. The results showed that the improved teaching method can effectively stimulate students' interest in learning, enhance students' learning initiative, improve students' ability to solve complex engineering problems in the field of radio-frequency identification, cultivate the spirit of teamwork among students, and nurture their innovative practical ability.

Keywords: OBE; RFID courses; Accreditation of Engineering Education; University-enterprise integration

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1. Introduction

The National Group Standard Information Platform has released the "Engineering Education Accreditation Standards" (T/CEEAA 001-2022) in China. As an engineering education quality assurance system, the engineering education professional accreditation is widely used across the world. The professional certification of engineering education has played an important role in higher education quality assurance and improvement [1,2]. The engineering education professional certification advocates three core concepts: student-centered, outcome-oriented, and continuous improvement in concepts. Outcome-based education (OBE) is an effective way to pursue excellence in education. It has achieved substantial results in the field of international engineering professional certification and formed a systematic theoretical system and operational formula [3].

In the context of professional certification of engineering education, China's higher education needs to better adapt to the needs of economic construction and social development in order to take advantage of the opportunities and overcome the challenges of the information revolution. It is the urgent to carry out education and teaching reforms under the guidance of OBE in order to to realize the transformation from subject-oriented to outcome-oriented, from teacher-centered to student-centered, and from quality monitoring to continuous improvement. In accordance with the requirements of engineering certification for engineering majors and under the guidance of the OBE philosophy, we have reformed the teaching

methods and evaluation systems of the radio-frequency identification (RFID) course.

2. Curriculum features and teaching status

The RFID course is an important basic course for Internet of Things engineering major. As an important communication technology for the interconnection of objects, RFID is the origin of information revolution of the Internet of Things. In this course, students are required to have the ability to learn knowledge, design and develop systems, analyze data, and write reports; students are also required to be able to learn independently, cooperatively, and inquiringly; they ought to value their family and country, be responsible and cooperative, abide by academic ethics, and uphold academic integrity. The purpose of this course is to enable students to master the transmission characteristics of RFID circuits, system comprehensive analysis, design methods, and practical RFID engineering applications from multiple levels, including electromagnetics, circuits, wireless transmission, and system design.

Under the background of engineering education professional certification, referring to the OBE philosophy, there are some problems in the teaching RFID courses.

(i) The teaching method focuses on theoretical knowledge, without much consideration on improving students' ability to comprehensively analyze and solve complex practical engineering problems in the RFID field. A huge gap exists between the teaching method and the skill training goals; moreover, the teaching concept is outdated. At present, the teaching of RFID courses is basically centered on textbooks, classrooms, and teachers. Students are accustomed to accepting knowledge passively, and they lack enthusiasm. In addition, students' understanding and mastery of basic theoretical knowledge are predominantly assessed through homework and final examinations, with little regard to the cultivation and evaluation of students' application skills. As an important part of practical training, the experimental course is also mostly based on verification experiments. The difficulty and depth of the experiments are far from complex engineering problems; thus, they are unable to cultivate students' innovative spirit and ability to solve complex engineering problems.

(ii) The teaching assessment and evaluation methods are monotonous and lack process evaluation. The overall evaluation in traditional courses includes only the usual grades and final exam results. The results of experimental practice are not listed separately, and a closed-book format with unified propositions is adopted in the final examination, which focuses on students' mastery of theoretical knowledge, and thus promotes rote memorization. The cultivation of students' comprehensive quality in analyzing and solving complex engineering problems is neglected. The assessment standards are uniform, and it is difficult to give a staged evaluation for each student.

3. Teaching reform based on outcome-based education

3.1. Improve teaching syllabus according to engineering professional certification standards

In order to cultivate students' ability, the curriculum design needs to be carried out around the curriculum objectives and expected outcomes. We have implemented the educational philosophy of OBE and revised the syllabus of the course in accordance with the talent training plan formulated by China Engineering Education Professional Certification Standards and the corresponding graduation requirements for the Internet of Things [4]. First, the course objectives are redesigned according to the graduation requirements; according to the course objectives, the teaching links are designed and implemented, and relevant online and offline course resources are built; the evaluation content is then set based on the course objectives and teaching links, which includes online tests, offline homework assessments, experimental ability evaluations, final exams, *etc*., and the achievement of course objectives is evaluated; lastly, according to the teaching quality evaluation results, the teaching content, teaching methods, teaching materials, *etc*., are continuously improved.

3.2. Reform teaching methods guided by cultivating students' ability

In the traditional teaching method, the focus is on teaching and classroom indoctrination. Guided by the educational philosophy of OBE, the training objectives are revised according to the curriculum. A step-by-step teaching method is adopted, dispersing important and difficult points in different teaching links, helping students concentrate on sorting out problems one by one and researching solutions. In the theoretical teaching of this course, the teaching strategy of "explaining theoretical knowledge points + engineering case analysis + cutting-edge report lectures" is adopted, while the teaching method of "teacher's demonstration and guidance + students' hands-on practice + teacher-student interactive discussion" is adopted in experimental practice. In the course of the experiment, emphasis is placed on the cultivation of students' innovative spirit and practical skills.

3.3. Organic combination of theoretical and practical teaching

Ability training is taken as the goal; thus, we prioritize practical training in engineering education, use theoretical teaching to complement practical training, and pay equal attention to both theoretical teaching and practical training. In practical training, solutions are designed in a problem-driven and project-driven manner. Taking experimental teaching as an example, we reduce confirmatory experiments, increase comprehensive experiments, emphasize self-designed experiments, and add exploratory experiments for scientific research. Among them, comprehensive experiments incorporate task-driven learning to improve students' ability in analyzing and solving problems. In self-designed experiments, students work in groups, select their own topics and design plans, discuss and improve via online/offline discussion, and complete the design goals. In this way, students' teamwork is cultivated under a multidisciplinary background. Students participate in exploratory experiments by joining their teachers' scientific research team; topics are chosen for the purpose of solving scientific research problems, and students are guided by their teachers to conduct exploratory and individualized research, learning, and innovation experiments. Through this, students' comprehensive analysis and design ability to solve complex engineering problems in the field of RFID is cultivated, and they would be able to embody innovative consciousness and humanistic spirit in engineering practices [5].

3.4. Revise course syllabus according to professional certification standards

The General Office of the State Council of China issued a report titled "Several Opinions on Deepening the Integration of Industry and Education." In this report, it has been pointed out that under the new situation, the integration of industry and education is of great significance to improve the quality of education, expand employment and entrepreneurship, promote economic transformation and upgrading, as well as cultivate new drivers of economic development. There is a need to actively carry out industry-university-research cooperation with enterprises and government agencies. While serving the local areas, in-depth industry-university-research cooperation can greatly exercise and improve teachers' practical application skills. At the same time, teachers are also actively mobilizing students' initiative in scientific research practice, assisting in the completion of industry-university-research cooperation projects, and transforming them into project reserves. Professionals can be invited to schools to conduct relevant professional knowledge training, expand student participation, and absorb new members [6]. For instance, the technical personnel of Hefei STC Electronic Technology Co., Ltd. can be invited to conduct hardware training and practice for students. In our school, there are several teachers and students who actively participated in the construction of "Artificial Intelligence Industry College." Based on the needs of Anqing City for environmental monitoring and governance as well as ecological protection, its cooperation with Anqing City Ecological Environment Bureau, Agriculture Committee Fishery Bureau, and other departments has resulted in the establishment of a chemical IoT monitoring platform, the active exploration of intelligent monitoring, the protection of

finless porpoise, and the optimization of the targeted training of high-quality application-oriented talents.

3.5. Improve course evaluation and continuous improvement

The achievement mechanism and effectiveness of curriculum objectives have become one of the effective means to measure the scientific and standardized quality of talent training. The achievement evaluation of course objectives is an important basis for ensuring the quality of teaching and promoting continuous improvement. It also provides basic materials for the evaluation of achieving graduation requirements [7]. Course evaluation includes the evaluation of the course itself and the achievement of certain skills among elective students, enabling the analysis of the main problems in the teaching process. The specific implementation steps are as follows: (i) summarizing the basic data in the teaching process; (ii) calculating the achievement value of each goal based on the assessment results of students; (iii) analyzing the achievement of skills according to the achievement value of course goals; (iv) proposing specific improvement measures for the problems and implementing continuous improvement.

4. Conclusion

Guided by the educational philosophy of OBE, combined with the characteristics and teaching status of the RFID course, the following five aspects of curriculum teaching research and improvement have been carried out: improving course syllabus according to the certification standards of engineering education, reforming the teaching method to cultivate students' ability, organically combining theoretical and practical teaching, deeply integrating production with education, promoting school-enterprise cooperation and collaborative education mechanism, as well as improving curriculum evaluation and continuous improvement. In addition, OBE has been implemented. The entire set of reform plans for this course has been tested on four classes of 2019 and 2020 majoring in Internet of Things Engineering in our school. Through the above curriculum reform measures, students' interest in learning has been effectively stimulated, students' learning initiative and innovation skills have improved, and favorable teaching effects have been achieved.

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Disclosure statement

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