Constructing an IoT Engineering Curriculum for Engineering Education Accreditation

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Abstract. Starting from the requirements of engineering education accreditation for professional talent training, this paper analyzes the relationship between talent training objectives and curriculum system construction. Taking the IoT engineering major as an example, it develops graduation requirements and index points that cover the standards of engineering education accreditation, based on the targeted positioning of talent training objectives. A professional curriculum system and practical training curriculum system are constructed to support the achievement of graduation requirements based on the index points. Curriculum evaluation and continuous improvement are conducted to optimize course content and teaching methods, improve teaching quality, better meet the learning needs of students, and enhance the quality of talent training.

Keywords: Engineering Education Accreditation, Internet of Things Engineering program, Curriculum System.

1 Introduction

With the rapid development of IoT technology, IoT engineering has become one of the important emerging majors in the current and future[1]. Engineering education accreditation is an international quality assurance system for engineering education, aimed at improving the quality of engineering education and enhancing the comprehensive quality and competitiveness of engineering professionals[2-3]. Engineering education accreditation is based on the "student-centered, output-oriented, continuous improvement" concept, and focuses on cultivating students' ability to "solve complex engineering problems". It systematically designs and implements all aspects of talent training objectives, graduation requirements, curriculum system, teaching implementation, evaluation and feedback[4]. Currently, many universities in China have begun to explore and practice the construction of IoT engineering professional curriculum system oriented to engineering education accreditation[5]. However, how to construct an IoT engineering professional curriculum system that meets the standards of engineering education accreditation is still an issue that needs to be studied. Among these many factors, the curriculum system is an important basis for professional teaching and an important carrier for achieving talent training objectives and specifications.

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2 Basis for Curriculum System Construction

Engineering education accreditation corresponds to professional construction, which should have a top-down standard system: "training objectives meet social needs - graduation requirements support training objectives - curriculum system supports graduation requirements - teaching activities implement the curriculum system - faculty complete teaching activities - supporting conditions meet teaching needs". Focused on engineering education accreditation, the curriculum system construction should start from the positioning of talent training objectives[6]. With the training objectives, there are graduation requirements, and with the graduation requirements, there is a curriculum system[7]. Based on this, a professional curriculum system and practical training curriculum system that support the achievement of graduation requirements are constructed.

2.1 Talent Cultivation Objective Positioning

In the context of engineering certification, taking application-oriented universities as an example, the talent training objectives of the Internet of Things engineering major should include the following aspects: possessing a solid theoretical foundation and broad knowledge covering multiple disciplinary fields such as computer science, communication engineering, and electronics technology, and mastering solid mathematical and natural scientific knowledge as well as professional knowledge in the field of IoT; possessing certain innovative and research capabilities, capable of engaging in scientific research related to IoT engineering, possessing the ability to solve practical problems, and constantly innovating and developing in the field of IoT engineering; possessing team collaboration and project management capabilities, capable of cooperating with team members, coordinating various resources, effectively managing projects, and ensuring the smooth implementation and completion of projects; possessing certain practical and engineering technical abilities, capable of engaging in system planning, analysis, design, implementation, operation and maintenance work in IoT engineering, possessing the ability to solve practical problems, and capable of adapting to the rapid development and changes in the field of IoT engineering; possessing good humanistic literacy and professional ethics, having social responsibility and good communication skills, capable of engaging in related work in the field of IoT engineering, and making contributions to social development.

2.2 Graduation Requirements

According to the "Interpretation and Usage Guide of the Generic Standards for Engineering Education Accreditation (2022 Edition)", there are five technical requirements including engineering knowledge, problem analysis, design/development solutions, research, and use of modern tools, as well as seven non-technical requirements including engineering and society, environmental and sustainable development, professional ethics, personal and team, communication, project management, and lifelong learning. Whether the professional graduation requirements/observation points clearly express the ability characteristics of the professional talents and whether the described abilities

can support the professional career abilities of the graduates is a question that needs to be addressed[8-9].

Each graduation requirement corresponds to multiple indicators, and each indicator has detailed indicator interpretations. According to the "full coverage and measurable" principle, each indicator point is supported by multiple courses.

2.3 Curriculum System

The achievement of graduation requirements requires course support. In the "Interpretation and Usage Guide of the Generic Standards for Engineering Education Accreditation (2022 Edition)", minimum credits are specified for different types of courses: mathematics and natural science courses that are appropriate for the graduation requirements of the major (at least 15% of the total credits), engineering basic courses, professional basic courses, and professional courses that meet the graduation requirements of the major (at least 30% of the total credits), engineering practice and graduation design (thesis) (at least 20% of the total credits), and humanities and social sciences general education courses (at least 15% of the total credits). In addition to the proportion requirements, the course setting can "support" the achievement of graduation requirements[10]. The term "support" includes two meanings: first, the entire course curriculum can support all graduation requirements, that is, in the course matrix, each graduation requirement has suitable courses to support, and the supporting relationship can be reasonably explained. Second, each course can realize its role in the course system, that is, the course outline clearly establishes the correspondence between course objectives and related graduation requirements; course teaching content, teaching methods, and assessment requirements can effectively ensure the achievement of course objectives; the course assessment method, content, and scoring criteria are designed based on the course objectives, and the assessment results can prove the achievement of the course objectives.

2.3.1 Professional Curriculum System.

According to the talent training objectives and graduation requirements, the major has designed a four-level curriculum system consisting of "general education platform," "disciplinary basic education platform," "professional education platform," and "innovation and entrepreneurship education platform".(see Table 1)

Table 1. Four-level Practical Content

Course Category		Specific Course
General Education Platform	Military Education	Military Training,Military Theory
	Political Theory Course	China's modern history and The outline,Situation and policy,Political theory courses and Comprehensive practice
	Health and Safety Education	University Physical Education,College Students' Mental Health Education,College Students' Safety Education
	College English	College English

	Labor Education	Labor Education,Practical Work Experience
	Quality Development	Humanities and Social Sciences/Art and Aesthetics/Health Promotion/Practical Expansion
Subject Basic Education Platform		Advanced Mathematics, Discrete Mathematics, Linear Algebra, Probability Theory and Mathematical Statistics, Programming Foundation, Circuit and Digital Logic, Introduction to the Internet of Things
Professional Education Platform	Core Professional Courses	Data Structure and Algorithm, Computer Organization Principles, Computer Network, Operating System, Sensor Principles and Applications, Embedded System Design and Development, Database Principles and Applications
	Professional Development Courses	Engineering Operations Direction, Intelligent Hardware Direction, Elective Courses
Innovation and Entrepreneurship Education Platform	Innovation and Entrepreneurship Courses	Innovation and Entrepreneurship Education for College Students, Career Planning and Employment Guidance for College Students, IT Industry Innovation and Entrepreneurship Guidance
	Innovation and Entrepreneurship Practical Experience	Second-Class Practice Activities

The general education platform includes courses such as military education. The disciplinary basic education platform focuses on basic courses based on mathematics and physics. The professional education platform consists of core courses and extended courses, which aims to cultivate students' ability to solve complex engineering problems and develop cross-disciplinary skills. The innovation and entrepreneurship education platform adapts to the requirements of innovation and entrepreneurship.

2.3.2 Practical Training Curriculum System.

Undergraduate engineering education emphasizes the core of "training students to solve complex engineering problems", and practical teaching is one of the important aspects of it. From the perspective of sequential training in knowledge, abilities, and competence, the program has established a four-level practical teaching system: basic experimental projects, comprehensive practical projects, innovative practical projects, and job-oriented practical projects.

Basic experimental projects include college physics experiments, programming foundation course design, electronic process training, sensor principle and application course design, and embedded system design and development course design. Comprehensive practical projects include IoT system integration training, IoT application design comprehensive training, and mobile application training. Innovative practical projects include intelligent IoT system design and development, and sensor network application development. Job-oriented practical projects include graduation practice and graduation project (dissertation).

3 Curriculum Evaluation

The evaluation of course offering is first based on the category proportion meeting the requirements of engineering certification, followed by the evaluation of teaching process, and finally the evaluation of achievement of course objectives.

The complete teaching evaluation should consist of three stages: first, designing observation methods to observe target behaviors and collect corresponding information data - "obtaining evidence"; second, analyzing and interpreting the collected information - "interpreting evidence"; and third, drawing corresponding evaluation conclusions based on different evaluation objectives - "diagnosing evidence". The rationality of the evaluation from at least two aspects: first, the evaluability of the learning objectives themselves; and second, the matching of the assessment and evaluation methods used with the target objectives to be evaluated.

The achievement of course objectives is generally divided into direct quantification and indirect interview. The achievement data is derived from the course team's development of an evaluation index framework, which divides the teaching content into different objectives and tasks to match the second-level indicators of graduation requirements through questionnaires and interviews with students and teachers. The student's performance (including homework, midterm exam, final exam) is further divided into small knowledge points and weighted according to the determined weights. The original data of each student's learning tasks in each course are collected, and the indicators are quantified. The scores are entered into the system for teaching, and finally, the system will generate a comprehensive score for the course and complete the achievement comparison of the objectives.

4 Continuous Improvement

Continuous improvement is a crucial aspect of engineering certification. Apart from hardware and faculty development, software improvements can be made through the following: ① Establishing a mechanism to evaluate the achievement of course objectives. After the course ends, conduct a questionnaire survey or an oral inquiry to understand students' evaluation of the achievement of course objectives. Analyze the achievement of course objectives based on the evaluation results, identify issues, and make improvements. ② Strengthening the updating and optimization of course content. With the continuous development of IoT technology, course content needs to be updated and optimized in a timely manner. Through cooperation with industry experts and enterprises, introduce the latest technology and practical cases to maintain synchronization between course content and industry development. ③ Improving teaching methods and means. Adopt multiple teaching methods and means, such as case teaching, project practice, group discussion, etc., to enhance students' learning experience and participation. At the same time, utilize modern educational technologies, such as online courses, virtual experiments, teaching aids, etc., to improve teaching effectiveness. ④ Strengthening practical training. IoT engineering is a highly practical major, and practical training is crucial for students to master knowledge and skills. Increase

practical courses and projects, provide more practical opportunities for students, and improve their practical ability and innovative spirit.

5 Conclusions

With the development of the healthcare information technology industry, there is an urgent need to cultivate "medical and engineering integration" talents with cutting-edge technology clinical research and its application. IoT technology is the core technology of smart healthcare, therefore, it is necessary to upgrade and transform the practical teaching model of the IoT engineering major, integrating IoT technology with medical applications, achieving the four-dimensional ability goals of "professional cognition ability, comprehensive design ability, development and innovation ability,and engineering application ability" to meet the social talent demand.

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