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Research on the Practical Teaching System of Internet of Things Engineering Major Based on the Training Mode of Engineering and Technological Talents

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Abstract

Under the background where the cultivation of engineering and technological talents has become the core orientation of higher education, the optimization of the practical teaching system for the Internet of Things (IoT) Engineering major plays a crucial role in promoting the high-quality development of the discipline and adapting to industrial demands. Based on the core objectives of cultivating engineering and technological talents, this paper clarifies the value of practical teaching in the IoT Engineering major in responding to national strategies, conforming to the interdisciplinary characteristics of technologies, and enhancing students' employability. It analyzes the current problems existing in the practical teaching of this major, such as the disconnection between content and industry, insufficient platform resources, a single teaching method, and an unscientific evaluation system. Strategies are proposed, including reconstructing the practical content of industry-education integration, building a virtual-real integrated teaching platform, implementing a project-driven teaching method, and establishing an evaluation mechanism that emphasizes process and results. These efforts aim to construct a practical teaching system that meets the needs of cultivating engineering and technological talents, and realize the coordinated development of education and industrial progress.

Keywords

Engineering and technological talents; Internet of Things engineering; Practical teaching system; Industry-education integration; Project-driven

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1. Introduction

As a core component of the new generation of information technology, IoT technology has been deeply integrated into fields such as intelligent manufacturing, smart agriculture, and smart cities, and has become an important engine driving the development of the digital economy. Engineering and technological talents are the core force for technology implementation and industrial innovation, and the quality of their cultivation is directly related to the development level of the IoT industry. As the main position for cultivating talents in this field, the IoT Engineering major regards practical teaching as a key link connecting theoretical knowledge and engineering application, and also as the core path to achieve the goal of cultivating engineering and technological talents [1]. Currently, in the process of carrying out practical teaching in the IoT Engineering major in colleges and universities, affected by factors such as traditional teaching concepts, resource allocation, and the degree of industrial connection, some institutions still have problems such as outdated teaching content, insufficient platform support, and weak cultivation of students' innovative ability, which make it difficult to fully meet the cultivation requirements of engineering and technological talents who emphasize practice, excel in application, and are good at innovation. Based on this, guided by the training mode of engineering and technological talents, conducting a systematic study on the construction path of the practical teaching system for the IoT Engineering major is of great practical significance for solving current teaching pain points, improving the quality of talent cultivation, and promoting the accurate connection between the education chain and the industrial chain. It also provides a reference for the practical teaching reform of similar majors.

2. The necessity of cultivating IoT engineering and technological talents

2.1. Demands of national strategies and industrial development

China's "14th Five-Year Plan" clearly incorporates the development of the IoT industry into the national strategy and proposes to promote the in-depth integration of IoT and the real economy. At present, the scale of the IoT industry continues to expand, and there is a significant shortage of supply of scientific and technological talents with engineering practice capabilities. The demand for related positions will continue to grow in the next five years [2]. As the core position for talent cultivation, colleges and universities' IoT Engineering majors need to strengthen the cultivation of engineering and technological talents under the guidance of national strategies. By optimizing the practical teaching system, they can provide suitable professional talents for the industry, assist in the implementation of the digital economy strategy, and promote the IoT industry to move from technological research and development to large-scale application.

2.2. The interdisciplinary and integrative characteristics of IoT technology

IoT technology covers the perception layer, network layer, and application layer, involving multiple disciplinary fields such as electronic information, computer science, and communication engineering, presenting the characteristics of "interdisciplinarity and strong integration". This characteristic requires relevant talents to not only master a single technology but also can integrate and apply multiple technologies. Traditional theoretical teaching makes it difficult for students to understand the technical connection, logic, and engineering scenario application. Through practical teaching, students can complete the whole process of sensor selection, communication protocol debugging, and application system development in a simulated or real engineering environment, realizing the transformation from single technology learning to multi-technology integration application, and meeting the ability requirements of the integration and intersection of IoT technologies.

2.3. Enhancing students' core employability

In the current job market, enterprises' recruitment standards for IoT positions focus more on engineering experience and project capabilities, and graduates who only master theoretical knowledge find it difficult to meet the requirements. Under the guidance of engineering and technological talent cultivation, practical teaching enables students to come into contact with real engineering cases and accumulate project development experience through links such as project training and enterprise internships. For example, by participating in projects such as smart agriculture sensor deployment and industrial IoT data acquisition system development, students can master the complete process of demand analysis, scheme design, and system debugging, form personal project achievements, enhance their core employability, achieve a smooth transition from campus to workplace, and shorten the enterprise training cycle [3].

3. Current situation of practical teaching in the IoT engineering major

3.1. Disconnection between practical teaching content and industry

The update of practical teaching content in the IoT Engineering major of some colleges and universities is lagging, and it still focuses on basic confirmatory experiments, such as the performance test of a single sensor and the verification of a simple communication protocol, lacking comprehensive projects that match the actual needs of the industry. For example, in the teaching of the perception layer, only the measurement of sensor parameters is focused on, without involving the anti-interference design in industrial scenarios; the teaching of the application layer stays in the development of basic APPs, without integrating cutting-edge content such as edge computing and AI model deployment. At the same time, the connection between teaching content and industry standards and enterprise technical routes is insufficient. Most of the textbook cases are limited to the laboratory environment, without considering factors such as environmental complexity and cost control in actual engineering. As a result, students need to re-adapt to the enterprise technical system after graduation, and there is a significant gap between them and the job requirements.

3.2. Insufficient practical teaching platforms and resources

The weak supporting capacity of practical teaching platforms is a common problem. In terms of hardware, some institutions still use old sensors and communication modules, which cannot support the practice of new-generation technologies such as 5G and LoRa. Most laboratories adopt a layout of one device per person, lacking a system-level development environment, making it difficult to carry out comprehensive projects such as IoT system integration and debugging. In terms of software, laboratories mostly use open-source tools, without introducing enterprise commonly used development platforms such as Huawei IoT Studio and Alibaba Link Develop, making it difficult for students to be familiar with the actual development process. In addition, due to funding and regional restrictions, local colleges and universities have an insufficient number of off-campus practice bases, and their cooperation with enterprises mostly stays on the surface. Students lack the opportunity to contact the real engineering environment, and practical activities are limited to the campus.

3.3. Single teaching method and weak cultivation of innovative ability

Most institutions still adopt a one-way teaching mode where teachers demonstrate and students imitate. The process is fixed as teachers prepare experimental steps, students operate according to the instruction manual, and submit reports. In this mode, students are in a passive acceptance state and do not need to independently think about core engineering issues such as technology selection and problem troubleshooting [4]. For example, in the IoT node design course, teachers provide hardware schemes and code frameworks in advance, and students only need to complete welding and code copying, making it difficult to form systematic thinking. Most practical tasks are carried out in the form of individuals, lacking team cooperation on projects. Students cannot cultivate the ability of division of labor, cooperation, communication, and coordination. When facing complex engineering problems, their ability to independently analyze and innovate design is weak.

3.4. Unscientific assessment and evaluation system

The assessment and evaluation have the drawbacks of “emphasizing results over process” and “emphasizing theory over practice.” Most institutions take experimental reports as the main basis for assessment, and the evaluation criteria focus on the completeness of the format and the accuracy of data, ignoring students’ operational ability, thinking process, and problem-solving ability. For example, even if students make frequent mistakes in the experiment, they can still get high scores as long as they finally complete the report by imitation, which cannot reflect their real practical level. Some assessments still focus on theoretical written tests, examining content such as sensor principles and protocol definitions, which are disconnected from practical operations. In addition, the innovation dimension is not included in the assessment. The optimization schemes or innovative designs proposed by students are not recognized, which makes it difficult to stimulate their innovation enthusiasm and also unable to fully evaluating the effect of practical teaching.

4. Construction of a Practical Teaching System for IoT engineering major based on the training mode of engineering and technological talents

4.1. Reconstructing the Practical Teaching Content System of Industry-Education Integration

To cultivate engineering and technological talents as the core, combined with the technical trends of the IoT industry and the job requirements of enterprises, a four-level progressive practical teaching content system is constructed, including basic experiments, comprehensive training, engineering practice, and innovation incubation. The basic experiment level focuses on the verification of core technical principles, integrates courses such as electronic circuits and sensor technology, and sets up experiments such as "sensor data acquisition" and "ZigBee protocol communication" to consolidate basic operation capabilities. The comprehensive training level is oriented to system design, introducing projects adapted from real enterprise cases, such as the smart classroom environment monitoring system, requiring students to complete the whole process design from demand analysis to deployment [5]. The engineering practice level relies on school-enterprise cooperation, arranging students to participate in actual enterprise projects to be familiar with engineering specifications and development processes. The innovation incubation level encourages students to carry out innovative designs around industrial pain points through discipline competitions and innovation and entrepreneurship projects. In addition, a teaching guidance committee composed of college teachers and enterprise technical backbones is established to update the teaching content every semester, and incorporate cutting-edge technologies such as 5G + IoT, edge computing, and IoT into the training module, ensuring that the teaching content is synchronized with industrial technologies and realizing demand-oriented teaching under industry-education integration[6].

4.2. Building a Virtual-Real Integrated Practical Teaching Platform and Resources

Centering on the practical teaching content system, a three-in-one teaching platform consisting of on-campus laboratories, off-campus practice bases, and virtual simulation platforms is constructed to provide support for the cultivation of engineering and technological talents. On-campus laboratories are built in modules. An IoT system integration laboratory across modules is built to provide a system-level development environment to meet the needs of comprehensive training. The construction of off-campus practice bases focuses on both quality and efficiency. Long-term cooperation is established with local IoT enterprises and intelligent manufacturing parks, and targeted training agreements are signed. Enterprises provide practical positions and assign technical mentors, and colleges and universities adjust the teaching content according to the needs of enterprises to realize order-based training. In view of regional restrictions or the confidentiality requirements of enterprise projects, a virtual simulation platform is built. Using VR/AR technology to simulate scenarios such as industrial IoT workshops and smart city control centers, virtual training projects such as IoT equipment fault diagnosis and large-scale sensor network optimization are developed. Students can experience complex problems in the real engineering environment through immersive operations, making up for the shortcomings of the physical platform [7]. In addition, a practical teaching resource sharing platform is built to integrate resources such as experimental instruction manuals, enterprise technical documents, project case videos, and development toolkits for students' independent learning, breaking the limitations of time and space and improving the efficiency of resource utilization [8].

4.3. Implementing a diversified teaching method driven by projects

Abandoning the traditional teacher-led teaching mode, with projects as the core carrier, a diversified teaching method featuring project-driven, case teaching, and group cooperation is implemented to give full play to the dominant role of students and cultivate the practical ability and innovative thinking required by engineering and technological talents. Project-driven teaching runs through the entire process of practical teaching. Teachers design project tasks of different difficulties according to the objectives of different teaching stages, and clarify the project requirements, delivery standards, and evaluation indicators. In the basic experiment stage, small sensor data acquisition projects are designed, and students independently select sensors, design acquisition schemes, and write data processing codes [9]. In the comprehensive training stage, projects adapted from real cases are adopted, such as simplifying the enterprise's smart warehouse goods positioning system into a teaching project. Students complete the scheme design, hardware selection, system development, and debugging in the form of teams, and teachers only guide key links to guide students to solve problems independently. Case teaching focuses on linking theory with practice. Teachers introduce typical cases in the IoT industry, such as JD's unmanned warehouse IoT system and Wuxi's smart city project. By analyzing the technical architecture, implementation path, and engineering difficulties in the cases, students can understand the application logic of technology in actual scenarios. Group cooperative teaching is carried out in groups of 3–5 people, with clear division of roles such as team leader, technical development, and document writing, simulating the operation mode of enterprise project teams [10]. This not only cultivates students' abilities of communication, coordination, division of labor, and cooperation, but also stimulates their innovative thinking through in-group discussions and inter-group competitions, encouraging them to propose differentiated solutions. In addition, enterprise technical experts are invited to conduct enterprise lectures. Through a combination of online and offline methods, they explain cutting-edge industrial technologies and project practical experience, such as industrial IoT equipment anti-interference design skills and IoT system security optimization cases, to broaden students' engineering horizons [11].

4.4. Establishing a comprehensive evaluation mechanism emphasizing both process and results

Breaking the single evaluation mode centered on experimental reports, a three-dimensional comprehensive evaluation mechanism, including process evaluation, result evaluation, and ability evaluation, is constructed to fully reflect students' practical ability and innovative ability and ensure the quality of engineering and technological talent cultivation. Process evaluation runs through the entire process of practical teaching [12]. Relying on the smart teaching platform, students' participation is recorded, including the standardization of experimental operations, the completion degree of project progress, the contribution degree of team cooperation, and the initiative of problem-solving. For example, in the process of project development, teachers evaluate the depth of students' participation in links such as demand analysis, scheme design, and system debugging by checking students' code submission records, group meeting minutes, and problem debugging logs. By introducing the student mutual evaluation mechanism, team members score each other according to the completion of their assigned tasks and their performance in communication and cooperation, ensuring the objectivity of the evaluation. Result evaluation focuses on engineering practicality [13]. Instead of only focusing on the accuracy of experimental data or the completeness of reports, it takes the function realization degree, engineering standardization, and innovative value of project results as the core indicators. Ability evaluation focuses on the core abilities of engineering and technological talents, and sets three evaluation dimensions: problem-solving ability, system design ability, and innovative ability.

5. Conclusion

Constructing a practical teaching system for the IoT Engineering major based on the training mode of engineering and technological talents is a key path to meet industrial demands, solve teaching pain points, and improve the quality of talent cultivation. By reconstructing the practical teaching content of industry-education integration, building a virtual-real integrated teaching platform, implementing a project-driven teaching method, and establishing an evaluation mechanism that emphasizes both process and results, students' engineering practical ability, system design ability, and innovative ability can be effectively improved, and the core goal of "cultivating engineering and technological talents that meet the needs of the IoT industry" can be achieved.

Disclosure statement

The author declares no conflict of interest.

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