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Closed Loop Practice of Vocational Undergraduate Field Engineer Training in the AIoT Era

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Abstract

Against the backdrop of the deep penetration of AIoT (Artificial Intelligence Internet of Things) technology into various industries, IoT field engineers, as the core force connecting technology research and development with industrial applications, have a direct impact on the efficiency of industrial implementation due to their skill level. This article takes the industry education integration project between Hainan Vocational University of Science and Technology and Guangzhou Yueqian Communication Technology Co. Ltd. as a case study to explore the construction logic of the IoT terminal development training system and the on-site engineer capability evaluation mechanism. Through measures such as the school enterprise dual mentorship system, curriculum system reconstruction, joint construction of practical training platforms, and project-driven teaching, a closed-loop cultivation model of "industry demand teaching implementation capability evaluation" has been formed, providing a practical and replicable paradigm for achieving a precise match between talent cultivation in IoT engineering programs and enterprise employment needs, offering significant insights for similar institutions.

Keywords

AIoT; On site engineer; Vocational undergraduate program; Integration of industry and education; Closed-loop cultivation; IoT intelligent terminal

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1. Introduction

With the deep integration of artificial intelligence (AI) and the Internet of Things (IoT), AIoT technology is becoming the core engine driving the digital and intelligent transformation of thousands of industries. From smart home, smart agriculture to industrial Internet and smart city, a large number of smart terminal devices need to be deployed, connected, debugged, maintained and optimized. This process has given rise to a huge demand for a new type of technical talent - IoT field engineers. They not only need a solid theoretical foundation, but also strong engineering practical abilities to go deep into the field and solve full stack technical problems from hardware deployment, system integration to software debugging, and data cloud deployment[1].

However, the traditional higher education model often emphasizes theoretical teaching, which is somewhat disconnected from the latest technology and practical needs of the industry, making it difficult for graduates to quickly adapt to job requirements. As a key part of China's modern vocational education system, vocational undergraduate education has the core mission of cultivating compound technical talents with profound theoretical literacy and superb technical skills. Therefore, exploring an effective and precise training path for IoT field engineers that can meet industry needs has extremely important practical significance.

This article is based on the deep cooperation between Hainan Vocational University of Science and Technology and Guangzhou Yueqian Communication Technology Co., Ltd., focusing on the core field of IoT intelligent terminal development. It systematically elaborates on how to build a closed-loop training model of "industry demand teaching implementation capability evaluation", in order to provide a practical paradigm for the professional construction and talent cultivation of similar colleges and universities[2].

2. Core competencies and training challenges of on-site engineers in the AIoT era

2.1. Core Competency Model

A qualified IoT field engineer needs to possess a diverse and composite capability structure:

Hardware system analysis and testing capabilities: able to understand the hardware architecture of intelligent terminals (such as development platforms based on high-performance processors such as RK3568), and perform component selection, circuit analysis, fault diagnosis, and debugging.

Intelligent system porting and deployment capabilities: Master the cutting, porting, burning, and boot configuration of embedded Linux, HarmonyOS, and other operating systems.

Embedded application design capability: Proficient in C/C++, Python and other languages for low-level driver and application development, and able to control peripherals (sensors, actuators)[3].

AI application development capability: have basic AI model deployment and application capabilities, and can use terminal NPU (such as 0.8TOPS computing module) to complete simple edge computing tasks such as image recognition, voice recognition, etc.

Mobile and web application development capabilities: Able to develop Android/HarmonyOS apps or web front-end interfaces for monitoring and controlling IoT devices, achieving human-computer interaction.

Industrial network and protocol parsing capability: Familiar with industrial field and wireless communication protocols such as RS485, Modbus RTU/TCP, Wi Fi, LoRa, LTE, etc., and able to collect and parse data.

Cloud platform access and data visualization capabilities: Master IoT protocols such as MQTT, CoAP, HTTP, etc., achieve data migration to the cloud, and be able to use cloud platform APIs for secondary development.

Project practice and system integration capabilities: Possess full process project management skills including requirement analysis, system design, equipment selection, joint debugging and testing, document writing, etc.

2.2. Challenges Faced by Traditional Training Models

Lagging teaching content: The update speed of textbooks and courses is slow, making it difficult to keep up with the rapid iteration of AIoT hardware and software technology.

Insufficient training conditions: The experimental equipment is outdated and single, and there is a lack of comprehensive training platforms that can simulate real industrial scenarios (such as IoT industrial environment monitoring training platforms and intelligent agricultural training systems)[4].

Disconnected teaching staff: Teachers lack experience in frontline projects of enterprises and have insufficient understanding of new technologies, processes, and standards.

The evaluation mechanism is single: the assessment mainly focuses on theoretical knowledge written exams, lacking effective evaluation methods for engineering practice ability, innovation ability, and professional ethics.

3. Construction of a closed-loop training model of "Industry Demand Teaching Implementation Capability Evaluation"

In response to the above challenges, this project has developed a training model with industry education integration as the core and closed-loop circulation as the characteristic.

3.1. Starting point: Accurate insight into industry demand

The first step in school enterprise cooperation is to jointly conduct talent demand research. The enterprise side (Guangzhou Yueqian Communication Technology Co. Ltd.) has transformed a large number of customer project needs and technical pain points accumulated in intelligent hardware, industrial Internet and other fields into a talent capability list[5]. This list clearly indicates the specific technologies that on-site engineers need to master (such as HarmonyOS application development, Modbus protocol parsing, sensor data acquisition), the training platforms they need to be familiar with (such as IoT intelligent terminal development platform, industrial environment monitoring training platform), and the professional qualities they need to possess, becoming the starting point and foothold of all teaching activities.

3.2. Core: Refactoring the Teaching Implementation System

Teaching implementation is the core of the entire closed loop, and we systematically reconstruct it from four aspects: curriculum, resources, platform, and teaching methods.

3.2.1. Curriculum System Restructuring and Integration of "Job Competition Course Certificates"

Refactoring the curriculum system closely around the list of industry demand capabilities. Deeply integrate core courses such as "Development of Embedded Systems for IoT Intelligent Terminals" and "Development of Mobile Applications for IoT Intelligent Terminals" with the "1+X Vocational Skill Level Certificate Standards for IoT Intelligent Terminal Development and Design" to achieve "course certificate integration". Integrating real project cases of enterprises and the requirements of various vocational skills competitions ("competitions") into the curriculum teaching content and practical training projects ("courses"), ultimately aiming at the ability requirements of the target position ("position"), forming a "position competition course certificate" four in one curriculum system[6]. The course content is broken down into several clear teaching tasks, such as: The course of Embedded System Development is divided into five tasks: system porting, file IO programming, multithreading/multiprocessing, network communication, and sensor application development.

3.2.2. Co construction of Training Teaching Resources

The school and enterprise have jointly developed a series of three-dimensional teaching and training resource packages, such as the "Intelligent Terminal 1+X Course Integration Resource Package" and the "Intelligent Terminal Mobile Application Development Resource Package". These resource packages not only include traditional teaching courseware and experimental manuals, but more importantly, provide:

Teaching video: Micro videos recorded for key operations and complex concepts.

Experimental environment: A standardized experimental environment built on high-performance RK3568 development platform, HarmonyOS system, etc.

Project Case Library: Originating from real training cases of enterprise projects, covering multiple industries such as smart factories, smart cities, and smart agriculture. For example, 9 experiments were conducted on temperature and humidity/light/soil sensor data collection, ventilation/irrigation/shading system control based on the "Internet of Things Intelligent Agriculture Training System"; A comprehensive case study of industrial signal acquisition, protocol parsing, and data cloud deployment based on the "Internet of Things Industrial Environment Monitoring Training Platform"[7].

Test question bank and assessment standards: A supporting online examination system that supports both theoretical and experimental assessments.

3.2.3. Advanced Training Platform Support

The training platform is the material foundation for the transformation of abilities. This project introduces three major core platforms. As shown in **Figure 1**.

IoT Industrial Environment Monitoring Training Platform | IoT intelligent terminal development platform | IoT Intelligent Agriculture Training System

Figure 1. Supported Training Platforms

3.2.4. Project driven and dual mentorship system

In the teaching process, the "Project Based Learning (PBL) method" is fully adopted. Students work in groups, starting from requirement analysis, gradually completing the entire process of design, development, debugging, deployment, and testing, and ultimately completing a runnable IoT application system. Enterprise engineers and school teachers form a "dual mentor" team to jointly guide student projects. Enterprise mentors bring frontline engineering experience and the latest technological developments, responsible for project feasibility assessment and guidance on tackling technical challenges; school mentors are responsible for project management, theoretical guidance, and progress control. This model effectively bridges the gap between theory and practice.

3.3. Closed loop: Multidimensional Ability Assessment and Feedback

We have established a diversified capability assessment system to test teaching effectiveness and provide feedback to the industry demand side.

Process assessment: At each stage of the experiment and project, there are assessment points to evaluate students' hands-on ability, document writing ability, and teamwork ability.

Final assessment: comprehensively evaluate students' comprehensive ability level through 1+X vocational skill level certificate certification examination, course final project defense, and other methods. The pass rate of a certificate is a direct test of teaching outcomes.

Enterprise project acceptance: Real or highly simulated projects of the enterprise will be included as the assessment content of the graduation comprehensive training, with the participation of enterprise mentors and technical experts in the acceptance and scoring, and the evaluation criteria will fully benchmark the employment standards of the enterprise[8].

Data feedback: Using a supporting teaching management platform, collect student learning behavior data, experiment completion data, and assessment score data, conduct big data analysis, and generate learning reports. These data are not only used to evaluate students, but also to reflect on and improve curriculum design, teaching content, and methods, forming an internal cycle of "evaluation feedback optimization", thereby continuously improving the entire training system and making it more accurately adapted to the dynamically changing industry needs[9].

4. Practical Achievements and Reflection

Significant results have been achieved through the practice of closed-loop cultivation mode:

Students' ability has been significantly improved: students are no longer limited to theoretical knowledge, and have acquired comprehensive engineering practical skills. They have repeatedly achieved good results in the National Vocational College Skills Competition and the "Internet plus" Innovation and Entrepreneurship Competition. The "1+X" certificate pass rate is far higher than the national average. The award-winning achievements of students participating in various skills competitions over the past three years are as **Table 1**.

The quality of employment has significantly

Table 1. Core competencies and training challenges

No.	Competition Name (English)	Number of Awards
1	National College Student Computer Design Competition	45
2	Pan-Pearl River Delta University Student Computer Works Competition	6
3	China University Computer Competition - Artificial Intelligence Creative Competition	10
4	Hainan Provincial College Student RPA+AI Innovation Challenge	10
5	China University Computer Competition - Group Programming Ladder Tournament	16
6	Blue Bridge Cup National Software and Information Technology Professionals Competition	26
7	RPA+AI Developer Competition	11
8	Cross-Strait, Hong Kong and Macao University Student Computer Innovation Works Competition and Hainan Provincial University Student Computer Works Competition	13
9	RAICOM Robot Developer Competition	9
10	China University Computer Competition - Network Technology Challenge	3
11	China University Computer Competition - Mobile Application Innovation Competition and Cross-Strait Innovation Works Competition	22
12	Huawei ICT Competition	10

improved: graduates are highly recognized by cooperative enterprises and ecosystem enterprises, and can quickly start their careers with better starting salaries and career development prospects than students under traditional training models.

The teaching staff has been strengthened: school teachers have significantly improved their engineering practice ability and teaching level by collaborating with enterprise mentors for research and participating in enterprise projects, and have established a “dual teacher” teaching team.

Deepening of school enterprise cooperation: From initial equipment procurement to joint development of courses, co construction of training bases, co formation of teaching teams, and co research of technology projects, a mutually beneficial and win-win deep cooperation ecosystem has been formed.

Reflection and Prospect:

Despite achieving good results, this model still faces some challenges in practice, such as ensuring continuous investment of enterprise resources, adaptive reform of school management system, and continuous optimization of interdisciplinary composite curriculum system. Additional challenges include the rapid pace of technological iteration requiring continuous curriculum updates, significant variations in student foundational knowledge necessitating personalized training paths, and the temporal alignment of enterprise project timelines with academic schedules. In the future, we will further explore the construction of virtual training platforms based on digital twin technology, expanding training scenarios in a lower cost and more flexible way; At the same time, more emphasis will be placed on cultivating students’ innovation ability, cross-cultural communication ability, and sustainable development ability to cope with the broader development prospects of AIoT technology in the future. We also plan to establish a collaborative update mechanism for teaching resources, explore modular teaching and credit bank systems under the “job-competition-course-certificate” integration framework, and leverage open-source and cloud technologies to reduce long-term costs[10].

5. Conclusion

In the era of AIoT, cultivating qualified IoT field engineers is an important talent guarantee to support the upgrading of industrial intelligence. The cooperation practice between Hainan Vocational University of Science and Technology and Guangzhou Yueqian Communication Technology Co. Ltd. has shown that building a closed-loop training model of "industry demand teaching implementation capability evaluation" with real industry needs as the starting point, a reconstructed teaching implementation system as the core, and multi-dimensional capability evaluation as feedback is an effective path for cultivating technical and skilled talents at the undergraduate level in vocational education. This model integrates advanced training platforms, rich project cases, enterprise technical standards, and engineering culture into the entire process of talent cultivation through deep collaboration between schools and enterprises. It effectively solves the problem of disconnection between learning and application, achieves resonance between talent cultivation and industry demand, and provides a replicable educational solution to address future AIoT technological challenges and talent competition, offering valuable experience for the construction of IoT-related majors in application-oriented universities and vocational colleges.

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Disclosure statement

The author declares no conflict of interest.

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