Research on the Teaching Reform of Internet of Things Communication Technology in Application-Oriented Courses

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Abstract. Internet of Things Communication Technology is one of the core courses of Internet of Things Engineering. However, the traditional teaching model has gradually exposed many problems in practical applications, such as messy content and single teaching methods. Aiming at the characteristics of application-oriented courses, this paper conducts research on the teaching reform of Internet of Things Communication Technology. According to the current situation and existing problems of Internet of Things Communication Technology course, this paper formulates course teaching objectives, integrates and reorganizes course content, reforms teaching methods, adjusts experimental links, and optimizes the evaluation system. The improved course stimulates students' interest in learning and improves their enthusiasm for learning.

Keywords: Applied courses; Teaching reform; Communication technology; Blended teaching

1 Introduction

With the rapid development of Internet of Things technology, the application of Internet of Things communication technology in all walks of life is becoming more and more extensive. Internet of Things communication technology has not only changed people's lifestyles, but also had a profound impact on social and economic development [1]. However, in the face of the rapid development of the Internet of Things industry, how higher education can cultivate high-quality application-oriented talents with both solid theoretical foundation and practical ability has become an important issue that needs to be solved urgently.

On October 8, 2019, the Ministry of Education issued the "Opinions on Deepening Undergraduate Education and Teaching Reform and Comprehensively Improving the Quality of Talent Training", proposing to increase the proportion of independent learning time, guide students to read more, think deeply, ask questions, and practice diligently; based on the needs of economic and social development and talent training goals, strengthen the overall design of the curriculum system, promote classroom teaching revolution; and improve the academic assessment system that organically combines

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process assessment with result assessment [2]. Therefore, under this guidance, relevant professional courses should be reformed accordingly to cultivate innovative, application-oriented, and compound "new engineering" talents for the country.

The Internet of Things Communication Technology course is offered to students majoring in Internet of Things Engineering and is a core professional course in the training program for Internet of Things Engineering talents. This course is an application-oriented, theoretical and practical course that provides strong support for students to study subsequent professional courses, complete graduation projects, participate in various competitions, etc. It plays a significant role in improving engineering literacy and innovation and entrepreneurship capabilities [3].

In the current education system, traditional Internet of Things communication technology courses are mainly based on theoretical teaching, and the practical teaching link is relatively weak, resulting in students' lack of operational experience and problem-solving ability in actual work [4]. In addition, the course content is updated slowly and it is difficult to keep up with the pace of development of Internet of Things technology. After graduation, students face problems such as outdated knowledge and insufficient skills [5][6]. In order to meet the above challenges, this study reforms the teaching content, teaching methods, experimental plans, and assessment systems, aiming to cultivate application-oriented talents that meet the needs of the modern Internet of Things industry.

2 Current Teaching Status of Internet of Things Communication Technology Courses

In the teaching of IoT communication technology, traditional teaching is mostly based on classroom lectures and after-class exercises, with teachers teaching according to textbooks and students listening to the lectures. The biggest disadvantage of using traditional teaching methods is that it is difficult to stimulate students' initiative and creativity, and it is difficult to improve students' comprehensive practical ability [7].

2.1 Teaching Content and Knowledge Points Are Messy

Internet of Things Communication Technology course covers a wide range of communication technology fields, including basic knowledge of communication principles, WiFi technology, Bluetooth technology, RFID technology, ZigBee technology, mobile communication, NB-IoT technology, LoRa technology, etc. These contents each involve different technical principles, standards and protocols, making the course appear to be messy and lacking an overall logical structure and optimized teaching content integration. In order to improve the teaching effect, it is necessary to systematically integrate and optimize these knowledge points, build a clearer and more orderly teaching system, and ensure that students can fully understand and apply these complex communication technologies [8].

2.2 Single Teaching Method

At present, most IoT communication technology courses adopt traditional offline single teaching methods, such as lectures, demonstrations and slides. This teaching method is difficult to stimulate students' interest and enthusiasm in learning, and students' classroom participation is low. In order to teach this complex technical course more effectively, diversified teaching methods should be introduced, such as case analysis, group discussion, project practice, online teaching resources, etc., to enhance students' learning experience and participation.

2.3 Experimental Teaching Content Is Single

Existing experimental teaching form is often limited to teachers providing students with debugged programs to run, and students lack practical code development and debugging experience. This single experimental form fails to effectively cultivate students' hands-on skills and problem-solving abilities. To make up for this shortcoming, it is possible to consider introducing project-driven experiments to allow students to design, develop and debug IoT communication systems from scratch, which can better train their practical skills and ability to solve practical problems [9].

2.4 Single Course Assessment Method

The assessment method of the Internet of Things Communication Technology course mainly relies on final exams, supplemented by attendance and homework, but these methods fail to fully evaluate students' classroom participation and knowledge application ability. In order to more comprehensively evaluate students' learning outcomes, diversified assessment methods can be introduced, such as classroom performance evaluation, group project evaluation, laboratory report evaluation, etc. In addition, it is also possible to consider introducing open-ended questions or case analysis to evaluate students' ability to solve practical problems and their innovative ability, so as to better reflect students' comprehensive academic and practical abilities [10].

The Internet of Things Communication Technology course is an important professional course for the Internet of Things Engineering major. Under the current background of emphasizing the reform and construction of education and teaching, higher requirements are put forward for the teaching of this course to meet the requirements of the Internet of Things Engineering major to cultivate engineering application talents.

3 Teaching Objectives of Internet of Things Communication Technology Course

Based on the training objectives of the Internet of Things Engineering major of our school, combined with the graduation requirements and the characteristics of this course, the teaching objectives of the Internet of Things Communication Technology course are established in three dimensions: knowledge objectives, ability objectives and

quality objectives: (1) Knowledge objectives, master the relevant concepts of communication systems, master the principles, protocols, application scenarios, etc. of several Internet of Things communication technologies. (2) Ability objectives, be able to use the knowledge of Internet of Things communication technology to analyze and study complex problems, and have the ability to build Internet of Things communication systems. (3) Quality objectives, cultivate students' habit of continuous learning and promote the overall improvement of students' quality.

4 Teaching Reform Plan for Internet of Things Communication Technology Course

4.1 Reconstructing Teaching Content

The Internet of Things Communication Technology course contains a variety of communication technology knowledge points. The teaching content is messy and covers a wide range of knowledge. After research, considering that different Internet of Things scenarios require different Internet of Things communication technologies, according to the development trends of the industry, on the one hand, the current relatively mature Internet of Things communication technologies and emerging Internet of Things communication technologies are comprehensively selected as teaching content. On the other hand, the course teaching content is optimized and reorganized, and the teaching modules are integrated according to technology categories and application scenarios, and arranged in a logical order of learning, as shown in Figure 1. The first module is the foundation of Internet of Things communication, which mainly introduces the concepts related to Internet of Things communication and the basic knowledge of communication principles, making up for the problem that students majoring in Internet of Things Engineering have no previous courses on communication principles, and laying the foundation for learning various Internet of Things communication knowledge. The second module is short-range wireless communication technology, which studies ZigBee technology and Bluetooth technology, including the network system, routing protocol, application scenarios of ZigBee technology, and the basic principles and connection process of Bluetooth technology. The third module is radio frequency identification and local area network communication, focusing on the working principle of WLAN and the application and challenges of WLAN in the Internet of Things. RFID technology is reviewed in the form of review. In the Internet of Things Engineering training program of our school, there is a professional course "Radio Frequency Identification Principles and Applications", so there is no need to repeat the teaching in the Internet of Things Communication Technology course. The fourth module is low-power wide area network technology, including NB-IoT and LoRa, two relatively new but widely used communication technologies in the Internet of Things. Learn the working principles, technical characteristics and typical applications of these two technologies. The fifth module is mobile communication technology, which introduces the evolution of mobile communications and the key characteristics of the fifth generation of mobile communications, and understands the application and integration solutions of

mobile communication technologies in the Internet of Things. The last module is the comprehensive application and forward-looking technology of the Internet of Things. Through specific cases, it analyzes the integration and application of various communication technologies in actual Internet of Things solutions, and introduces the integration of the Internet of Things with new technologies such as AI, edge computing, and blockchain.

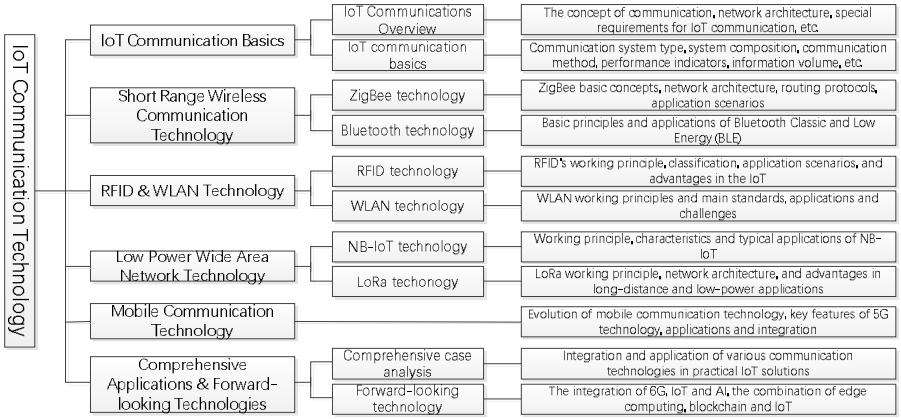

Fig. 1. Teaching content of IoT Communication Technology

By reorganizing and optimizing the course content, we can avoid the situation where the course content is cluttered with knowledge points and the teacher does not highlight the key points and difficulties of the lectures. Students can listen to the lectures clearly [11] and avoid confusion in the content they have learned. Students can have a holistic understanding of the knowledge system of the course and have a clearer understanding of the application of different communication technologies in the Internet of Things.

4.2 Improve Teaching Methods

(1) Online and offline hybrid teaching

The teaching of IoT communication technology uses the Chaoxing platform and enterprise WeChat course groups, combined with online learning resources such as MOOCs and micro-courses, to conduct online and offline hybrid teaching, enrich students' learning channels, and diversify students' learning methods. As shown in Figure 2, before the course starts, a teaching class group is established on Chaoxing and Enterprise WeChat, and a student list is imported. The course learning materials (syllabus, courseware, case materials, experimental instructions, question banks, etc.) are uploaded to the learning platform for students to preview before class and consolidate after class. The regular teaching of the course is divided into three stages: before class, the teacher guides students to learn course resources through the platform, actively participate in discussion activities on the platform, and collect and organize materials for thematic reports in groups; during the class, in the offline classroom, the teacher

explains the key and difficult knowledge points, combines case analysis to help students understand the theory, and each learning group reports and displays the learning results of their group; after class, students complete the course assignments under the guidance of the teacher, and teachers and students interact with each other on the online platform to further help students master the teaching content.

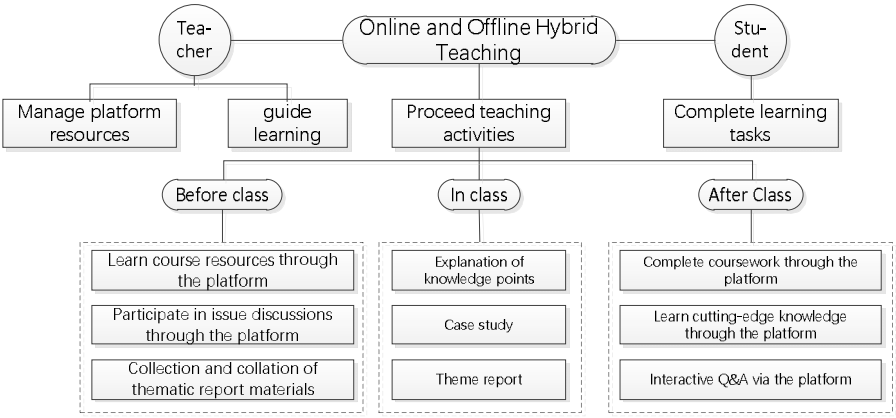

Fig. 2. Operation of online and offline hybrid teaching

Through online and offline hybrid teaching, learning content can be turned into problems, learning process can be explored, and learning activities can be networked, so that students' subjectivity can be realized; through online and offline hybrid teaching, the teaching space can be broadened, and students can obtain learning resources anytime and anywhere, forming an independent, cooperative, and interactive learning environment, which has a good effect on improving students' learning interest, cooperative learning ability, problem-solving ability, and information technology literacy [12].

(2) Group learning

In order to improve the learning effect, the students in the class are divided into several study groups, each with 4-5 people. First, according to the course content, the Internet of Things communication technology is divided into several modules according to different technical specifications. Students are free to choose groups according to their interests, knowledge background and skill levels. Each group claims a module and learns according to the various resources provided by the teacher. According to the assigned tasks, the study groups regularly discuss and learn, share experiences and solve each other's questions; according to the course schedule, each group is arranged to take turns to make periodic reports in class, report learning progress, main findings and difficult problems, and show learning results. During the report, the teacher and other groups raise questions or suggestions to help the group further improve the learning content; each group chooses a practical application project related to the module it is responsible for, and the members work together to design a simple Internet of Things system. Before the end of the course, each group prepares and presents its final project, and other groups give feedback and evaluation on the project presentation, and score according to the project's innovation, presentation quality and performance in

answering questions, while encouraging students to summarize and reflect. Finally, based on the experience in the implementation of group learning, the next course will be adjusted and the implementation method will be optimized. The whole group study period is explained in Figure 3.

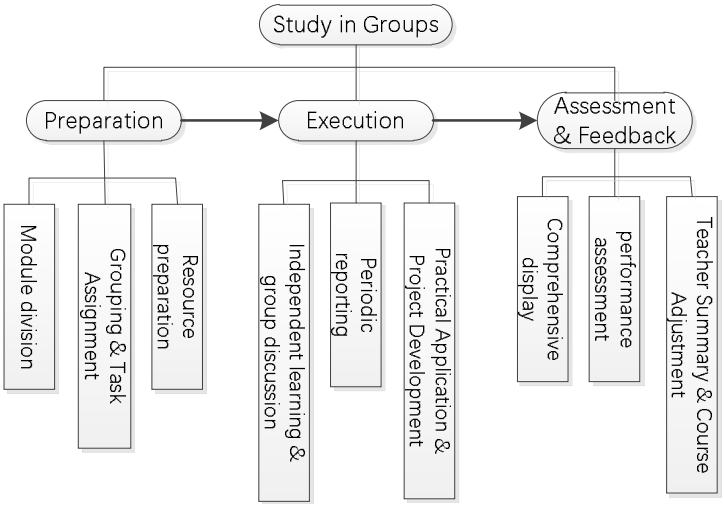

Fig. 3. Operation of group study

Through group learning, students can improve their teamwork and problem-solving abilities by conducting "searching for information and discussing before class - reporting and presenting during class - summarizing and improving after class" in groups.

4.3 Reform of Practical Teaching

In the 2023 training program of the Internet of Things Engineering major at Dongguan City College, Internet of Things communication technology has 16 experimental hours and a total of 8 experiments. According to the teaching sequence of each teaching module in Section 3.1, the following experimental projects are designed and arranged, as shown in Table 1.

Table 1. Arrangements for practical teaching

Teaching Modules	Experimental Project	Project Type	Experimental content
ZigBee Technology	ZigBee wireless lighting	verify	The coordinator module key switch controls the light on the terminal module
	ZigBee On-Demand	train	The terminal module and router module send information to the coordinator module
	ZigBee temperature and humidity collection	design	The sensor collects the ambient temperature and humidity and sends them to the gateway via the ZigBee network

WLAN Technology	WiFi Networking	verify	Configure AP and Station to build a LAN
	WiFi Remote Communication	train	Connect to OneNET cloud platform via WiFi and create devices on the platform
Bluetooth Technology	Bluetooth LED Control	verify	The host controls the LED on the slave
	Bluetooth serial port AT control	train	Realize Bluetooth connection and communication through AT commands
NB-IoT Technology	NB-IoT Communication	design	Realize data transmission and remote control of the pan/tilt via NB-IoT

In the practical teaching part, the experimental content is designed in layers and difficulty levels, and is divided into three levels: verification-training-design. All students are required to complete the verification experiments. Each training experiment operation is divided into two parts. The first part can be completed by correctly following the experimental steps. The second part is the improvement part, which requires students to modify the key codes in the project environment based on the first part. The design experiment is also divided into two parts. The first part uses the prescribed communication technology to wirelessly transmit the raw data of the sensor. The second part requires the design of a program to pack/unpack the data for remote reading in a more efficient and intuitive form.

In each experimental class, the teacher first explains the experimental content and breaks down the experimental requirements. Students perform the experimental operations according to their own abilities. After the experiment, the teacher will check the experimental results in class and score the operations based on the standardization of the operations and the completeness of the results. After class, each student will complete the experimental report independently, and the scores of the experimental report and experimental operation will be used as the total score of this experiment.

4.4 Improve the Evaluation System

The assessment of course grades pays more attention to the process, and adopts a multi-link evaluation and comprehensive assessment mechanism. The total score is divided into three parts: regular grades, experimental grades, and final written examination grades. Among them, regular grades and experimental grades each account for 20%, and final grades account for 60%. Regular grades are composed of attendance (5%), homework (5%), classroom performance/group presentation (5%), and online interaction (5%). Experimental grades are composed of experimental operation (10%) and experimental report (10%). The above assessment system can mobilize students' enthusiasm for learning and examine students' learning situation more comprehensively.

5 Conclusion

This paper analyzes the outstanding problems in the current teaching status of the course and proposes a reform plan for the construction of an application-oriented course on Internet of Things communication technology. Starting from the students' learning

situation, the teacher integrates the teaching content according to the technology category and application scenario, and then adopts online and offline hybrid teaching, in the form of group learning, so that students can fully master the principles and practical application scenarios of various communication technologies in Internet of Things communication. In the practical teaching part, the experimental content is designed in layers and difficulty levels, so that students of different levels can gain something from the experiment. On the one hand, this study promotes the reform and construction of the Internet of Things communication technology course. On the other hand, it can be used as a reference to expand to the construction of other professional courses in the Internet of Things engineering major, and play a positive role in promoting the cultivation of application-oriented talents in the Internet of Things engineering major.

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References

1. Li, S., Xu, LD, & Zhao, S. (2023). Internet of Things for Industry 4.0: A comprehensive survey. *IEEE Access*, 11, 87685-87705.
2. Ministry of Education. (2019). Opinions of the Ministry of Education on deepening undergraduate education and teaching reform and comprehensively improving the quality of talent training. Retrieved from http://www.moe.gov.cn/srcsite/A08/s7056/201910/t20191008_402370.html.
3. Zhang, Y., & Qian, C. (2023). Enhancing practical skills through IoT curriculum design: A case study in higher education. *Journal of Engineering Education,* 30(2), 45-58.
4. Wang, L., & Li, X. (2022). Enhancing practical skills through hands-on projects in IoT communication technology courses. *IEEE Transactions on Education,* 65(3), 789-798.
5. Sun, Y., & Sun, S. (2020). Challenges and strategies of IoT curriculum design in higher education. *IEEE Access,* 8, 206546-206556.
6. Zhang, Y., & Qian, C. (2021). Challenges and strategies of IoT curriculum design in higher education. *Journal of Educational Technology & Society,* 24(1), 123-135.
7. Wang, Y., Li, J., & Zhang, H. (2022). Application of active learning in IoT communication technology teaching. *IEEE Transactions on Education,* 65(4), 1234-1245.
8. Wang, Q., Wang, X., & Li, Z. (2023). Integration and optimization of IoT communication technology curriculum based on comprehensive knowledge structure. *Journal of Engineering Education,* 41(2), 345-360.
9. Chen, H., Zhang, L., & Wu, G. (2023). Project-based learning approach in IoT communication technology education. *IEEE Transactions on Education,* 66(1), 234-247.
10. Zhang, Y., Liu, X., & Wang, H. (2023). Diversified assessment methods in IoT communication technology education. *Journal of Engineering Education Research,* 30(2), 45-59.

11. Tan Yongqian. (2022). Research on the teaching reform of the "Internet of Things Communication Technology" course driven by Internet of Things applications under the background of new engineering. Journal of Science and Education (25), 90-93.
12. Zhang Song. (2020). [Online teaching without stopping learning] Teacher Zhang Song talks about regular teaching and online and offline hybrid teaching during the epidemic. http://ctld.scnu.edu.cn/a/20200229/1123.html.