Research on Virtual Simulation Teaching Practice Based on Internet of Things Specialty

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Abstract. The Internet of Things project belongs to the transformation major of application-oriented undergraduate. Therefore, the construction of talent training mode and curriculum system must be oriented by the industry's talent demand and aim at the cultivation of students' ability and quality. The development of technology leads to the short updating cycle of real equipment, high equipment price and long school purchasing cycle, which leads to the failure to update real teaching equipment in time. The virtual simulation experimental teaching center of the Internet of Things gives full play to the advantages of the computer experimental center, and builds a realistic virtual experimental teaching course by using the existing experimental equipment and resources of the experimental center according to the principle of combining reality with virtuality. Virtual learning situation analysis and teaching monitoring can promote knowledge, interest and autonomous learning ability to a certain extent. Through this research, front-line teachers can have a deep understanding of virtual simulation teaching, and great changes have taken place in teaching methods and learning methods, providing reference for teachers to carry out information-based practical teaching such as virtual simulation.

1. Introduction

With the rapid development of Internet of Things technology, all kinds of Internet of Things applications have been popularized in various industries in China. The whole society has an urgent demand for Internet of Things application technology talents, which requires universities to train more high-tech skilled talents of Internet of Things application technology to meet the needs of society [1]. The training goal of the Internet of Things engineering major is to face the national strategic emerging Internet of Things industry, base itself on the medical and health field, and pay attention to cultivating students' theoretical knowledge and practical skills of information acquisition technology, data communication technology, sensor technology, network technology, RFID technology and embedded system technology, and focus on cultivating compound senior technical talents with medical background in the field of Internet of Things [2-3]. The key to achieve the above goals lies in curriculum teaching. It is necessary to break the inherent teaching mode and build a new teaching mode and platform, such as using cloud classroom, virtual simulation experiment platform, flipping classroom and massive open online course in the teaching process.

The Internet of Things engineering major has strong applicability, and its core is to cultivate students' engineering practice ability. Virtual simulation technology is an advanced simulation technology, which combines simulation technology with virtual reality technology on the basis of information technology such as multimedia technology, simulation technology and network communication technology. Through virtual simulation, a complete virtual environment is built to meet relevant requirements. Virtual simulation experiment teaching simulates the real experimental environment through
virtual simulation experiment software. Students can verify the knowledge points they have learned through the platform and improve their practical ability.

2. Analysis on the current situation of practical links of internet of things courses

2.1. Analysis of traditional practice environment of internet of things

The experiment box and training platform of the Internet of Things are the experimental equipments adopted by many colleges and universities at present. They integrate all kinds of technologies into the experiment box or training platform, in order to carry out the experimental operation more conveniently, but there are the following drawbacks in this experimental teaching link [4-5].

(1) All kinds of equipment are integrated into an experiment box or training platform, which is convenient for experiment operation and equipment management. However, the flexibility of the experiment is poor, and it is not innovative, so students can only experiment according to the inherent mode.

(2) The equipments of the Internet of Things are basically electronic components. If the students' experimental operation is irregular, it is easy to damage the components and affect the normal experimental teaching.

(3) Although the direct operation of physical equipment has a deep intuitive impression, students can't intuitively feel the underlying communication principles and data, so there will be more delays in understanding knowledge.

(4) There are many kinds of IoT devices, which are easy to be damaged. Therefore, the maintenance of IoT laboratories is more difficult than other laboratories.

2.2. Application trend of virtual simulation software of internet of things

The emergence of virtual simulation software of Internet of Things can make up for the deficiencies in the teaching environment of real physical networking, simulate the setting of external environment parameters and various conditions, set up large-scale application scenarios of Internet of Things, and facilitate students to conduct independent experiments after class, which are beneficial to the development of students' innovative thinking and the cultivation of innovative ability.

Several Opinions of the Ministry of Education on Improving the Quality of Higher Education in an All-round Way and the Ten-year Development Plan of Educational Informatization (2011-2020) both require colleges and universities to deeply integrate information technology with higher education, innovate the talent training mode, change the talent training mode from knowledge and skills to application innovation, and pay attention to the cultivation of students' practical ability and innovative ability. The virtual simulation technology and its related software platform organically integrate the Internet of Things technology, information technology and higher education, which provides a powerful guarantee for the innovation of talent training mode.

3. Construction of virtual simulation experimental teaching center of internet of things

Virtual simulation experiment is to use virtual reality, multimedia, human-computer interaction and other information technologies to build a highly simulated experimental environment based on the existing experimental courses of the Internet of Things, so that students can learn in the virtual simulation experimental environment [7-8].

The virtual simulation experimental teaching center of Internet of Things has built a virtual simulation experimental platform by using existing experimental equipment and resources [9]. Twelve virtual simulation experiment courses were set up on the experimental platform. Enhance the interaction of experimental teaching, and realize the sharing of virtual simulation teaching and experimental course resources to a higher degree. At the same time, the virtual simulation platform makes full use of the school network resources, further promotes the virtual simulation experiment teaching, and then plays a demonstration and promotion role in Northeast China. In addition, it also improves the quality and level of experimental teaching, provides a platform for cultivating outstanding talents, and lays a solid
foundation for building the virtual simulation experimental teaching center of Internet of Things into a high-level practical teaching base.

4. Practical teaching design based on virtual simulation technology of Internet of things

4.1. Design principle of "four drives" in virtual simulation technology teaching

Based on Smith's and Reagan's teaching system design theory, combined with learning driving force, using 5W2H analysis method, this paper makes a systematic analysis of these theories to explain human learning behavior from different angles (as shown in Figure 1), and generates the rudiment of the design principle of virtual simulation technology teaching, which in the final analysis focuses on students' subjective initiative and individualized learning, so that virtual simulation technology can be better integrated into teaching. Therefore, four design principles of virtual simulation experiment are summarized, namely, vivid principle of single student, quick action principle of students, interaction principle of students and students, and linkage principle between teachers and students.

![Fig. 1. 5W2H](image)

(1) Vivid principle of single student

Students can learn vividly only when they move, and the creation of students' autonomous learning environment is the key to the cultivation of students' autonomous learning. Therefore, the virtual simulation technology is gamified, and according to the relevant principles of gamification teaching, the gamification teaching model and strategy implementation are designed, so that students can complete their learning independently without supervision.

(2) Students and the principle of machine intelligence

The ecological interaction between students and the virtual simulation system is the key to students' intelligence, that is, to endow the virtual simulation system with "intelligence", which is not difficult to realize at present. By using the open Turing robot platform, students can directly experience the beginning of problem analysis, design, implementation and effect evaluation from the robot.

(3) Principle of interaction between students and students

The interaction between students and students can be reflected in the position between individual students, study group and study whole, so that students can achieve the happy atmosphere of chasing after each other. Meanwhile, the traces left by virtual simulation operation can be transmitted to other students in the same operation online.

(4) Principle of teacher-student interaction

In pursuit of students' aspirations, they wish they could be in a stress-free, vibrant and professional classroom. Teachers in the classroom guide us to complete pieces of knowledge and tasks one by one, share a relaxed classroom, and get ideal results. There are two principles of this linkage: first, under the condition of intelligence, students are still not positioned accurately, and teachers can guide them, which can be imagined as a transformation from intelligent assistant to manual puzzle solving.

4.2. Experimental course management system

According to the four design principles of virtual simulation experiment, that is, vivid principle of single student, quick action principle of students, interaction principle of students and students and linkage principle of teachers and students. For a class that needs to prepare lessons, whether it is a
theoretical course, a sub-project operation model course or a comprehensive course, it is necessary to follow the teaching process of conventional courses: teaching analysis, teaching design, teaching application and evaluation, and teaching improvement, as shown in Figure 2.

Fig. 2. General flow of virtual simulation teaching

The functions of the experimental course management system mainly include student user information management, experimental placement, experimental environment setting, experimental report management, evaluation records and results publishing. It provides teachers with the functions of student user management and grade management for all classes in experimental courses, and also supports the personalized setting of experimental courses, such as customizing the grouping number of experimental courses and the experimental environment of experimental courses according to the training needs and objectives of experimental courses.

In the experimental placement function, teachers can add experimental classes, delete experimental classes and manage student user information of experimental classes. It also supports the maintenance of individual students' user information, and the setting of experimental classes provides a basis for the functions of experimental report management, experimental process record and evaluation of subsequent experimental courses.

The experimental report management function mainly includes five functional modules: report release, evaluation strategy, evaluation record, score management and score statistics. Experimental report publishing function can maintain experimental content templates, and add, delete and edit experimental templates. When publishing scores, if there is uncommitted or unrated information about students' experimental courses, the teacher can choose whether to inform the students, and the student users can also receive the notification information of results publishing in the personal information center. In the score statistics function, you can view the results of each student's experiment report and experiment process record, and also view the statistical information such as the number of submitted students and the correct rate of the topics in the experiment report.

4.3. Teaching process design of virtual simulation technology teaching in comprehensive project-based courses

Comprehensive project type is the summary of sub-projects, which reflects the growth cycle of the whole project. It is the general trend to face up to future jobs from design, construction to acceptance, and to carry out comprehensive project training, which lays the foundation for training professional talents, can enhance students' comprehensive professional ability and sustainable development, and can better prepare for integrating into society and serving society [10]. On the platform of the national 1+X pilot project, the post docking training teaching from senior one to senior three was carried out. On this basis, combined with the skill master studio, skilled craftsmen were introduced into the classroom, and the whole process of work-oriented teaching was carried out in combination with the engineering practice of enterprises, so that the
teaching tasks and teaching process could be docked with the whole process of enterprises, and students could get in touch with practical engineering projects in their study career, which not only expanded the skills training, but also made a smooth transition between training students in schools and recruiting employees in enterprises.

Fig. 3. Teaching process of virtual simulation technology teaching in comprehensive project-based courses

The teaching process can refer to the project-based teaching process design, and the virtual simulation teaching can flexibly intersperse the knowledge and contact before class (upload the virtual simulation platform), build a strong beam in class, use the virtual simulation platform to scan the code to obtain tasks, organize cooperation and group construction, and display the results and check and accept them, as shown in Figure 3.

4.4. Progressive practical teaching design

The experimental teaching design concept of the virtual simulation experimental platform of Internet of Things is: from easy to difficult, from simple to complex to innovative design concept, so that students can learn gradually through the simulation platform. The simulation experiment is divided into four stages.

(1) Cognitive experiment

This stage is the cognitive stage, which enables students to have a more perceptual understanding of the Internet of Things and its related equipment and applications through various kinds of simulated IoT devices, components, simulation sandboxes and 3D simulation environment in the simulation platform.

(2) Replication experiment

At this stage, students can improve their mastery of common technologies and skills of Internet of Things, such as RFID technology, WSN technology, Internet of Things programming technology, etc. Students can enter the virtual simulation experimental platform of the Internet of Things, select corresponding RFID equipment components and sensor components to build a virtual experimental environment of the Internet of Things, and use their own testing tools to test the operation of the equipment and verify the basic process of communication.

(3) Design experiment

At this stage, students will make use of the convenience of the simulation platform to build a small application scenario of the Internet of Things, build an application environment in the simulation platform according to the requirements of experimental tasks, and refer to the experimental guidance and routines to develop their own equipment in the real programming development environment, obtain data or control the simulation equipment.

(4) Innovative experiment

This stage is mainly designed for students who are interested and spare no effort. Students can adjust IoT devices and redevelop IoT applications through the typical industry IoT application system.
provided by the simulation platform, and can link virtual environment with real environment, and control virtual devices in the simulation platform through real environment applications.

Take the teaching design of Integrated Access Control Construction as an example. Through organizing discussion and animation simulation, help students analyze mistakes, and stimulate students' interest in learning through VR/AR. According to that "self-inquiry learning sheet" and ar submit by the students, this paper analyzes the cause and consequences of building structure errors. In group training, the video analysis system is used to repeatedly emphasize safe operation and standard operation, and highlight the teaching emphases of system installation process, system equipment installation, wiring and debugging in actual operation. Compared with the "training acceptance standard", the training operation, process and comprehensive evaluation promote the achievement of teaching objectives. Use the student behavior evaluation software, three divisions and three grades to generate a histogram (as shown in Figure 4).

Fig. 4. Scoring of each group of comprehensive projects

Students use virtual simulation technology to completely experience the process from design transformation to site construction to acceptance and delivery, which makes the working process systematic. Due to the limitation of curriculum conditions, there is no important link in the drafting of comprehensive projects, which is only aimed at equipment replacement, installation, (threading) adding a twisted pair and debugging of new equipment, which is in line with the later maintenance of the Internet of Things specialty. Therefore, in the follow-up course comprehensive training project, under the condition that the training resources of the school cannot be matched, the volunteer team of the school Internet of Things is designed, and the engineering company is contacted to provide the students with the actual construction environment. The quality of the project is borne by the school, and the school-enterprise cooperation cooperates to educate people, so as to forge ahead in Do not forget your initiative mind.

5. Conclusion
The construction of virtual simulation experimental teaching system relies on virtual simulation software, aiming at cultivating college students' independent innovation spirit and engineering practice ability, introducing virtual technology, simulation technology and multimedia technology, exploring the teaching mode of "modularization, hierarchy and diversification", breaking through the traditional mode in teaching methods and means, and realizing interactive teaching of experimental simulation cases. The application of virtual simulation technology of Internet of Things in the experimental teaching of Internet of Things application technology major in universities helps to solve the problems of high professional construction cost and difficult laboratory management. Its abundant experimental resources provide students with a more intuitive experimental environment with more obvious results,
which is conducive to cultivating students' innovative thinking ability and changing their learning methods. It is an effective teaching method in the current educational informationization.

References

[1] Klsch J, Heinz C, Ratzke A, et al. Simulation-Based Performance Validation of Homomorphic Encryption Algorithms in the Internet of Things[J]. Future Internet, 2019, 11(10):218.

[2] Thornton M, Motalleb M, H Smidt, et al. Internet-of-Things Hardware-in-the-Loop Simulation Architecture for Providing Frequency Regulation With Demand Response[J]. Industrial Informatics IEEE Transactions on, 2018, 14(11):5020-5028.

[3] Wang K M, Hui L. Effectiveness evaluation of Internet of Things-aided firefighting by simulation[J]. The Journal of Supercomputing, 2017(3):1-15.

[4] Miao Y, Li W, D Tian, et al. Narrowband Internet of Things: Simulation and Modeling[J]. IEEE Internet of Things Journal, 2017:2304-2314.

[5] Hao Cuixia, Hui Ye. Research on virtual simulation teaching of Industrial Robot training course[J]. experimental technology and management, 2018, 035(006):144-146.

[6] Kecskemeti G, Casale G, Jha D N, et al. Modelling and Simulation Challenges in Internet of Things[J]. IEEE Cloud Computing, 2017, 4(1):62-69.

[7] Ito T, Rahman M, Mohamad E, et al. Internet of things and simulation approach for decision support system in lean manufacturing[J]. Journal of Advanced Mechanical Design Systems and Manufacturing, 2020, 14(2):1-12.

[8] Mershad K, Wakim P. A Learning Management System Enhanced with Internet of Things Applications[J]. Journal of Education & Learning, 2018, 7(3):23.

[9] Wang Hao. Thinking and Practice of Virtual Simulation Experiment Teaching of Road and Bridge Engineering Construction Course[J]. teaching of forestry region, 2019, 000(004):103-105.

[10] Zhang Yang. Simulation of Fault Risk Assessment for Laboratory Equipment in Internet of Things[J]. Computer simulation, 2019, 036(002):153-156.