Exploration of Course Reform of the Sensor Technology and Application Based on Outcome-Based Education: A Case Study of Internet of Things

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Abstract: With the rapid development of Internet of Things technology, sensor technology, as a key supporting technology, occupies an important position in the curriculum system of Internet of Things. Guided by the concept of Outcome - Based Education (OBE), this paper comprehensively explores the reform necessity, goal setting, optimization of teaching content and teaching methods, and improvement of evaluation system of sensor technology and application courses for Internet of Things majors, and puts forward relevant implementation paths and measures, aiming at improving the education and teaching quality of sensor technology and application courses. To meet the needs of the new era to train high-quality applied talents to meet the needs of the Internet of Things industry.

Keywords: OBE; IOT; Sensor; Technology and application; Course; Reform

1.Introduction

As an important part of the new generation of information technology, the Internet of Things is widely used in various fields, such as smart agriculture, smart home, intelligent transportation, industrial monitoring, etc. [1]. As the core device of the perception layer of the Internet of Things, sensors are responsible for collecting various information in the physical world and converting it into processable electrical signals, providing the basis for subsequent data transmission, processing and decision-making. Therefore, the sensor technology and application course is one of the core courses of the Internet of Things major, and it is of great significance to improve the teaching quality of the sensor technology and application course for cultivating students' professional skills and practical ability.

However, the traditional sensor technology and application course teaching often has some problems, such as the teaching content focuses on theoretical knowledge, and the practical application is not closely combined; The teaching method is mainly taught by teachers, and the initiative and creativity of students are difficult to play; The practice teaching has too much verification and is not comprehensive. The evaluation method is simple and the evaluation measures are obsolete, which cannot fully reflect the learning results of students [2]. These problems lead to students' insufficient understanding and grasp of the course content and insufficient application ability, which is difficult to meet the needs of talents in the Internet of Things industry.

The concept of Outcome-Based Education (OBE) emphasizes student-centered education, focusing on the final learning outcomes achieved by students, and designing the teaching process and evaluation system according to the expected learning outcomes to ensure that students can obtain truly valuable learning experience and improve their abilities [3,4]. Introducing the concept of OBE into the sensor technology and application course reform of the Internet of Things major will help solve the problems existing in traditional teaching, improve the quality of course teaching, and cultivate high-quality IOT professionals who meet the needs of the industry.

2. The Necessity of Curriculum Reform Based on OBE Concept

2.1 Meet the Needs of the Industry

The requirements for sensor technology talents in the Internet of Things industry not only include a solid theoretical foundation, but also emphasize practical application ability, innovation ability and team collaboration ability.

The students cultivated under the traditional teaching mode are often disconnected from the theory and practice, and it is difficult to quickly adapt to the needs of the job. The curriculum reform based on the OBE concept and the setting of teaching objectives and achievements oriented to the needs of the industry can make the knowledge and skills of students more suitable for the actual work scene and improve the employment competitiveness of students [4].

2.2 Improve the Learning Effect of Students

Traditional teaching pays attention to imparts knowledge, students are in a passive state of acceptance, learning enthusiasm is not high. The OBE concept is student-centered, focuses on students' learning process and outcomes, and encourages students to study independently and inquiry-based [5]. Through a variety of teaching methods and practical activities, stimulate students' learning interest, improve students' learning initiative and creativity, so as to enhance students' learning effect.

2.3 Promoting Continuous Curriculum Improvement

The OBE concept emphasizes evaluation and feedback based on learning outcomes. Through the analysis of students' learning outcomes, problems existing in the teaching process can be found in time, and then teaching content, methods and evaluation methods can be adjusted accordingly to promote continuous improvement of courses and improve teaching quality [6].

3. Curriculum Goal Setting Based on OBE Concept

3.1 Clarify the Expected Learning Outcomes

According to the training objectives and industry needs of the Internet of Things major, combined with the characteristics of sensor technology and application courses, the following expected learning outcomes are determined:

3.1.1 knowledge level

(1) Accurate grasp of the basic theory of the sensor: a thorough understanding of the basic concept of the sensor as a key component of information acquisition, and a clear grasp of its working principle of converting non-electrical quantities such as physical quantities and chemical quantities into electricity or other forms of signals that are easy to handle. Master the classification methods according to different standards, such as measured physical quantity, working principle, output signal type, etc., and be able to accurately describe the characteristics and applicable scenarios of various classification methods, laying a solid foundation for further study.

(2) Deeply familiar with the characteristics and applications of common sensors: for the common sensors widely used in the field of Internet of things, such as temperature sensors, humidity sensors, pressure sensors, acceleration sensors, in-depth understanding of their performance indicators, including range, accuracy, resolution, sensitivity, linearity, etc., clearly grasp the impact of each indicator on the practical application of the sensor. Comprehensively familiar with its working characteristics, such as the response time of temperature sensors, hysteresis characteristics of humidity sensors, etc., and in-depth study of the specific application methods of various sensors in different application scenarios, such as the application points of temperature sensors in smart home environment monitoring, the use of pressure sensors in industrial equipment condition monitoring skills.

(3) Deeply understand the principle and design of signal conditioning circuit: deeply understand the core principle of sensor signal conditioning circuit, understand its important role in compensating sensor output signal defects and improving signal quality. Proficient in amplifier circuit design methods, reasonable selection of amplifier types (such as operational amplifier, instrument amplifier, etc.) and design the corresponding circuit parameters; Proficient in filter circuit design, according to the frequency characteristics of different interference signals, design suitable low-pass, high-pass, band-pass or band-stop filters, effectively filter noise; In-depth learning of linearization processing methods, for sensors with nonlinear output characteristics, can use hardware circuits or software algorithms to realize the linearization of output signals to ensure the accuracy of signal processing.

3.1.2. ability level

(1) Accurate selection ability: In the face of diverse practical application needs, we can accurately select the most appropriate sensor based on a deep understanding of various sensor performance indicators, working characteristics and application scenarios, and comprehensively consider cost, reliability, power consumption

and other factors. At the same time, according to the output signal characteristics of the selected sensor and the requirements of the subsequent processing circuit, the signal conditioning circuit is reasonably designed or selected to ensure the optimization of the performance of the whole sensing system.

(2) System construction and debugging ability: skilled use of the sensor knowledge, combined with the architecture principle of the Internet of Things sensing system, to independently build a simple Internet of Things sensing system. From the selection, installation and connection of sensors, to the design and debugging of signal conditioning circuits, to the implementation of interfaces with microcontrollers or data acquisition devices, the hardware construction of the entire system can be completed in an orderly manner. At the same time, master the basic methods of system debugging and testing, can use oscilloscope, multimeter and other tools to detect and analyze circuit signals, by writing test programs to verify the accuracy of sensor data acquisition, timely find and solve the hardware failures and software logic problems in the process of system construction, to ensure the stable and reliable operation of the system.

(3) Data processing and analysis ability: proficient in the basic methods of sensor data acquisition, including analog signal digital conversion (such as A/D conversion principle and application), data acquisition interface (such as SPI, I2C, USB, etc.) use. Be able to use professional data processing software (such as MATLAB, Python data analysis library, etc.) to conduct in-depth analysis of the collected sensor data and dig the valuable information behind the data. At the same time, master the basic methods of data visualization, and be able to use charts (such as line charts, bar charts, scatter charts, etc.) and graphical interfaces to visually present the analysis results, providing clear data support for decision-making.

(4) Innovative optimization ability: On the basis of in-depth understanding of the existing sensor application system, with keen observation and innovative thinking, can find the shortcomings and improvement space in the system. Through consulting the cutting-edge technical information, learning from the advanced experience in related fields, applying the learned knowledge and skills, the existing system is innovatively optimized and improved.

3.1.3. quality level

(1) Shaping of rigorous scientific attitude: In the course learning and practice process, students' rigorous and meticulous scientific attitude is cultivated through in-depth exploration of sensor principles, accurate measurement and analysis of experimental data, repeated demonstration and optimization of system design and other links. Students are required to adhere to the principle of seeking truth from facts in the treatment of every experimental data and every design detail, not falsification, not perfunctory, to ensure the authenticity and reliability of learning and research results, and to lay a solid foundation of professional ethics for future scientific research and engineering practice.

(2) Improvement of team cooperation and communication ability: Through organizing students to participate in group projects, such as the design and development of iot sensor application system, students can clarify their individual roles and responsibilities in a team environment, learn to listen to others' opinions and suggestions, give full play to their own advantages, and cooperate closely with team members to complete project tasks together. In the process of project implementation, students need to communicate effectively, so as to improve their teamwork and communication skills, so that they can better integrate into the team and play an active role in the future work.

(3) Self-learning and engineering literacy training: With the rapid development of sensor technology and the Internet of Things industry, new knowledge and new technologies continue to emerge. Through course guidance and practical exercise, students' independent learning ability is cultivated, so that they can actively pay attention to industry trends, timely learn and master new sensor technology, signal processing methods and other knowledge. At the same time, in the process of solving practical engineering problems, students are guided to use engineering thinking, comprehensive consideration of technical feasibility, economic rationality, environmental adaptability and other factors, and gradually cultivate students' engineering literacy, so that they have the ability to analyze and solve problems from an engineering perspective, and make full preparation for becoming an excellent IOT engineer in the future.

3.2 The Relationship Between Curriculum Objectives and Graduation Requirements

The course objectives are clearly related to the

graduation requirements of the Internet of Things major to ensure that the course teaching can effectively support the achievement of the graduation requirements. For example, through practical projects in the course, students are equipped with the ability to solve complex engineering problems, which supports the requirements of the application of engineering knowledge, problem analysis and design/development of solutions in the graduation requirements; Through group cooperative learning, students' teamwork and communication skills are cultivated, which corresponds to the requirements of individual, team and communication in graduation requirements [7].

4. Teaching Content Optimization Based on OBE Concept

4.1 Integration of Teaching Content

Break the chapter limitation of traditional teaching content and integrate sensor technology knowledge with actual application scenarios as clues. For example, taking the intelligent agricultural system as an example, the application of temperature sensors, humidity sensors, light sensors, etc. to the agricultural environment monitoring part is focused on explaining, so that students can clearly see the collaborative work of different sensors in the same application scenario.

Simplify theoretical teaching content and highlight key points and key knowledge points. For some complex theoretical derivation, only a brief introduction, focusing on the application of theoretical knowledge. For example, when explaining the working principle of photoelectric sensors, through practical cases and experimental demonstrations, students can intuitively understand how sensors convert physical quantities into electrical signals, rather than being too entangled in the derivation of theoretical formulas.

4.2 Integration of Cutting-Edge Technologies and Industry Cases

Pay attention to the development of sensor technology and integrate cutting-edge technology into teaching content in a timely manner. For example, the principles and applications of new sensors (such as smart sensors, nanosensors, etc.) are introduced to broaden students' horizons and enable them to understand the latest development trends of the industry [8].

Introduce a large number of practical industry cases, such as equipment condition monitoring in smart factories, environmental monitoring and precision irrigation in smart agriculture. Through the analysis and explanation of these cases, students can understand the specific application of sensor technology in different fields, and cultivate students' engineering application ability.

4.3 Strengthen Practical Teaching Links

Increase the proportion of practice teaching, and increase the proportion of practice teaching hours to more than 30% of the total teaching hours. Set up a rich variety of practical projects, including basic experiments, comprehensive experiments and project design.

Basic experiments: mainly for the principle verification and performance testing of a single sensor, such as temperature characteristics testing of temperature sensors, static calibration of pressure sensors, etc. Through these experiments, students are familiar with the basic operation and testing methods of sensors, and deepen their understanding of the working principle of sensors.

Comprehensive experiment: Under the background of practical application scenarios, students are required to build a simple iot sensing system using a variety of sensors [9]. For example, to design an indoor environment monitoring system based on multi-sensor fusion, students need to select appropriate temperature, humidity, light and other sensors, design signal conditioning circuits, and realize data acquisition and display. Through comprehensive experiments, students can develop their ability of system design and debugging.

Project design: Arrange micro-scientific research projects with certain difficulty and innovation, such as the design and implementation of smart home and smart agricultural greenhouse control system. Students complete the project in group form, from demand analysis, scheme design, hardware construction, software programming to system debugging, comprehensively training students' engineering practice ability and team cooperation ability.

5. Teaching Method Reform Based on OBE Concept

5.1 Adopting Diversified Teaching Methods

Project-based teaching method: taking the actual project as the carrier, integrating the course knowledge into the project. In the process of project implementation, under the guidance of teachers, students independently complete the needs analysis, program design, implementation and testing of the project. For example, when explaining the sensor selection and signal conditioning circuit design, the project of "intelligent greenhouse environmental monitoring system" is arranged, so that students can choose the appropriate sensor according to the requirements of greenhouse environmental monitoring, and design the corresponding signal conditioning circuit. Through project-based teaching, students' learning initiative and ability to solve practical problems are improved.

Problem-oriented teaching method: In the teaching process, a series of enlightening questions are put forward to guide students to think and explore. For example, when explaining the nonlinear characteristics of sensors, it is proposed that "how to linearize the nonlinear output of sensors?" And other problems, let students find solutions through consulting information, discussion and other ways. Problem-oriented teaching method is helpful to cultivate students' independent learning ability and innovative thinking.

Group cooperative learning method: Students are divided into groups to complete practical projects and discussion tasks together. In group cooperation, students show their strengths, learn from each other, and develop teamwork and communication skills. For example, in the course design project, the division of labor within the student team is clear, and they are respectively responsible for hardware design, software programming, document writing and other work, so as to jointly complete the project objectives.

5.2 The Use of Information Teaching Means

Build online course platform, such as wisdom tree, cloud class, learning Pass, etc. Upload course teaching resources (such as teaching courseware, video tutorials, online tests, etc.) to the platform, so that students can learn anytime and anywhere. Through the online course platform, students can preview course content, review key knowledge, complete online homework and tests assigned by teachers, and learn about their own learning situation in time.

Use Internet of Things virtual simulation experiment teaching software to assist practical teaching. For some complex experimental projects or experiments that cannot be carried out due to experimental conditions, students can simulate operations through virtual simulation software. For example, virtual simulation software is used to simulate the working conditions of sensors under different environmental conditions, as well as the joint debugging process of sensors and signal conditioning circuits, so that students can be familiar with the experimental process and operation methods in the virtual environment, and improve the experimental teaching effect.

6. Improve the Assessment and Evaluation System Based on the OBE Concept

6.1 Establish Diversified Assessment Methods

Change the traditional single assessment method of final examination, and establish a diversified assessment and evaluation system combining process assessment and final assessment. The process assessment accounts for 40% of the total grade, and the final assessment accounts for 60% of the total grade.

Process assessment: including attendance, class performance, homework, experiment report, online learning, project stage results, etc. Through the comprehensive tracking and evaluation of students' learning process, we can timely understand students' learning progress and existing problems, and give students timely feedback and guidance. For example, in the classroom performance evaluation, students' participation, speech quality, teamwork and other aspects are concerned; In the evaluation of the experimental report, students should pay attention to the understanding of the experimental principle, the analysis of experimental data and the summary of experimental conclusions.

Final assessment: The combination of final examination and project design is adopted. The final exam mainly examines the students' mastery of the basic knowledge of the course, including multiple choice questions, blank filling questions, short answer questions, analysis questions, calculation questions, etc. The project design focuses on the comprehensive application ability and innovation ability of students, and evaluates the performance of students in the project design project, such as the rationality of

the scheme design, the integrity of the system implementation, and the innovation.

6.2 Evaluation Based on Learning Outcomes

Formulate detailed assessment indicators and evaluation criteria based on the expected learning outcomes of the course [9]. For example, for the learning achievement of "ability to select appropriate sensors and signal conditioning circuits according to actual application needs", in the assessment and evaluation, the accuracy of students' analysis of application needs, the rationality of sensor selection, and the correctness of signal conditioning circuit design are evaluated.

In the assessment and evaluation process, focus on the quantitative analysis of students' learning outcomes. Through the statistics and analysis of students' various assessment results, we can understand students' achievement in various learning outcomes, find out existing problems and deficiencies, and provide basis for subsequent teaching improvement.

7. Implementation and Effect of Curriculum Reform

7.1 Reform Implementation Process

In the teaching of sensor technology and application courses for Internet of Things majors, the curriculum reform based on OBE concept has been gradually implemented. First of all, revise the curriculum syllabus to clarify the reform ideas and specific requirements in terms of curriculum objectives, teaching content, teaching methods, assessment and evaluation methods [10]. Secondly, teachers should be organized to participate in relevant training to improve their understanding and application ability of OBE concept, so as to ensure the smooth implementation of the reform. In the teaching process, teachers carry out teaching activities according to the new teaching methods and assessment system, pay attention to the interaction and communication with students, and timely understand the learning situation and feedback of students.

7.2 Analysis of Reform Effects

Improving students' learning enthusiasm: By adopting diversified teaching methods and introducing practical project cases, students' learning interest is stimulated, and students' learning initiative is significantly enhanced. The participation of students in class increased, and the number of active questions and discussions increased. After class, students actively consult materials and complete practical projects and coursework independently.

Improvement of practical ability: After strengthening practical teaching, students' practical operation ability and engineering application ability have been significantly improved. In the course design project, students can comprehensively apply the knowledge they have learned to design and implement the iot perception system with certain functions, and some students' works are also innovative and practical. Students have also achieved good results in participating in various discipline competitions and innovation and entrepreneurship projects.

Continuous improvement of courses: Through the analysis and evaluation of students' learning results, problems existing in the teaching process can be found in time, such as excessively difficult teaching content and insufficient practical teaching resources. To solve these problems, teachers timely adjust the teaching content and teaching methods, increase the practical teaching equipment and software resources, and constantly optimize the course teaching, which promotes the continuous improvement of the course.

8. Conclusion

Based on the results-oriented sensor technology and application curriculum reform, guided by the concept of OBE, it makes a comprehensive exploration from the setting of curriculum objectives, the optimization of teaching content, the reform of teaching methods and the improvement of assessment and evaluation system. Through the reform, it has improved students' learning enthusiasm and practical ability, cultivated students' innovative spirit and teamwork ability, and made course teaching more in line with the needs of talents in the Internet of Things industry. However, curriculum reform is a continuous process, which requires continuous summing up of experience in future teaching practice, further optimizing teaching content and methods, and improving the assessment and evaluation system, so as to adapt to the rapid development of the industry and the diversified needs of students, and lay a solid foundation for cultivating high-quality iot professionals.

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