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Research and Practice of "1141" Research-Based Teaching Model

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Abstract: In the process of practical research-based teaching of engineering majors in applied undergraduate universities, there are common problems such as the first-class research-based teaching focuses on form but not substance, research-based teaching is regarded as an "extracurricular activity" outside the daily teaching process, and research-based teaching evaluation focuses on terminal evaluation but not developmental evaluation. This paper takes the Internet of Things Engineering major as an example, innovates and practices the "1141" research-based teaching model, and takes talent training programs, classroom teaching, second classroom, and practical teaching reform as practical approaches to construct a "two-classroom" linkage mechanism and a multi-evaluation mechanism to cultivate students' ability to discover, analyze and solve problems using scientific thinking and methods. Practice shows that this model can effectively improve students' ability level and comprehensive quality, and provide strong support for the certification of engineering education majors.

1. Research-Based Teaching

Theoretical research on research-based teaching started early. With the continuous development of higher education, the concept and connotation of research-based teaching given by the times are also evolving[1]. In the China National Knowledge Infrastructure Academic Journal Network Database, a large amount of information can be retrieved with the keyword "research-based teaching " . The authors of these research results are mostly from research-based universities. From the distribution of research results, they mainly focus on the following three aspects : first, compare and learn from the experience of foreign research-based teaching reform, and put forward construction suggestions based on the actual situation in China ; second, deeply analyze the current situation of research-based teaching reform in domestic universities, and then put forward targeted construction countermeasures ; third , take the research-based teaching reform of a certain university in China as a specific case, summarize its experience and look forward to future development prospects. However, in the process of practicing research-based teaching in engineering majors in applied undergraduate universities, there are generally problems such as focusing on form rather than substance in the first classroom research-based teaching, treating research-based teaching as an "extracurricular activity" outside the daily teaching process, and

focusing on terminal evaluation rather than developmental evaluation in research-based teaching evaluation[2] .

This study takes the Internet of Things Engineering major as an example, takes moral education as the fundamental task, focuses on the goal of " improving students' scientific research innovation and practical ability" , grasps the teaching program of" problem- countermeasure- questioning- innovation" , insists on problem-oriented, innovates and practices the " 1141 " research-based teaching model, constructs a " two-classroom " linkage mechanism and a multi-evaluation mechanism, effectively solves the problems existing in the current research-based teaching of applied undergraduate colleges and universities, stimulates students' interest and curiosity in learning, and cultivates students' ability to discover, analyze and solve problems using scientific thinking and methods[3].

2. Research on the “1141” research-based teaching model

The first " 1 " refers to defining a goal of " enhancing students' scientific research innovation and practical ability " , integrating the target ability into the 12 graduation requirements for engineering education professional certification, and laying a target support for the implementation of research-based teaching ; the second "2" refers to designing a " problem-countermeasure-reflection-innovation " teaching program that conforms to the characteristics of scientific research , and integrating the teaching program into the entire process of research-based teaching ; " 4 " refers to constructing a curriculum system at four levels of " theory-experiment-practical training-second classroom " , designing course groups according to ability requirements, selecting research courses with scientific research characteristics from the course groups, using knowledge graph technology to reconstruct the teaching content of research-based teaching courses, and carrying out traditional teaching and research-based teaching in a layered and classified manner. The research-based teaching is implemented for middle and high school students, and adopts the teaching method of "problem-driven theoretical teaching, case-driven experimental teaching, project-driven practical training teaching, and competition-driven second classroom". The third " 1 " refers to making full use of the school's mature " teaching, practice, creation, transformation and integration " educational practice approach, gathering high-quality resources for the integration of industry and education, and improving the scientific research innovation and practical capabilities of teachers and students through dual teaching, teachers and students learning together, teachers and students working together, teachers and students creating together, and teachers and students transforming together[4].

This project will take the Internet of Things Engineering major of Pingdingshan University as an example, and map " improving students' scientific research innovation and practical ability " one-to-many to the 12 graduation requirements of engineering education certification, strengthen the ability training of " problem analysis, design/development solution, application research " , etc., and plan 6 course groups to strengthen the ability step by step according to four levels, and 8 research courses are scattered in different course groups. 4 courses are selected as demonstration courses, and the whole process is tracked from reconstructing knowledge to implementing teaching.

3. Practice of “1141” research-based teaching model

3.1. Practice of “1” Goal

The Internet of Things Engineering major has been revised on the basis of the 2022 talent training program, with the clear training goal of " being able to track cutting-edge technologies in Internet of Things engineering and related fields in product development and solution design,

having innovation and good practical ability, and being able to apply new technological achievements to engineering practice ". The specific requirements for research have been clarified in the graduation requirements for problem analysis, design/development of solutions, and applied research.

3.1.1. Innovative analytical capabilities

We need to possess the thinking methods required to solve complex engineering problems in the field of Internet of Things, have good problem analysis ability, be able to apply the basic principles of mathematics, natural sciences and engineering sciences, accurately identify and correctly express, and conduct comprehensive analysis of complex engineering problems through literature research to obtain effective conclusions.

3.1.2. Innovative design capabilities

We need to be able to apply the principles and methods of IoT technology to design solutions to complex engineering problems in the IoT field, develop hardware and software systems or components that meet specific needs, and be able to demonstrate innovation in the design/development process, taking into full consideration social, health, safety, legal, cultural and environmental factors.

3.1.3. Innovative research capabilities

Possessing the theory and core technology of the Internet of Things, and being able to use scientific methods to study complex engineering problems in the field of the Internet of Things based on the principles related to the Internet of Things engineering discipline, including designing experiments, analyzing and interpreting data, and obtaining reasonable and effective conclusions through information synthesis, and exploring the scientific laws and general methods for solving complex engineering problems in the application field of the Internet of Things. Based on scientific principles, through literature research or related methods, you can investigate and analyze solutions to complex engineering problems in the field of the Internet of Things; based on relevant principles and using scientific methods, you can formulate experimental plans for software, hardware, modules, and systems in complex engineering problems in the field of the Internet of Things[5]; you can build experimental systems according to experimental plans, use experimental equipment to conduct experiments safely, and correctly collect experimental data; you can analyze and interpret experimental results, and obtain reasonable and effective conclusions through information synthesis.

3.2. Practice of “1” teaching program

We need to design a "problem-solution-reflection-innovation" teaching program that meets the characteristics of the Internet of Things Engineering major , and integrate the teaching program into the entire process of research-based teaching ;

"Problems" are the starting point of research-based teaching. Teachers guide students to discover problems and raise research questions by creating real problem situations. For example, in the Internet of Things Engineering course, students are asked to analyze the technical problems or optimization space in actual Internet of Things application scenarios, such as smart homes and smart transportation[6].

"Countermeasures" stage requires students to apply the knowledge and skills they have learned to come up with ideas and methods to solve problems. Teachers provide guidance and help in this

process, guiding students to conduct literature review and solution design.

"Reflection" is a key link in the teaching process. After implementing countermeasures, students reflect on the entire process, summarize experiences and lessons, and discover new problems and deficiencies.

"Innovation" is the sublimation of the teaching program. Based on reflection, students put forward new ideas, methods or solutions to expand their knowledge and improve their abilities.

The application of teaching program in research-based teaching runs through the whole process of research-based teaching, from course design to teaching implementation, from classroom learning to practical links. For example, in theoretical teaching, teachers can guide students to actively learn and think in a problem-driven way; in experimental teaching, students design experimental plans according to problems and verify the effectiveness of countermeasures through experiments; in practical training teaching, projects are used as carriers to let students discover problems, solve problems and innovate in practice; in the second classroom, through activities such as subject competitions, students' innovative thinking and practical ability are further stimulated.

3.3. Practice of the “4” Level Curriculum System

It refers to building a curriculum system with four levels of " theory-experiment-practical training-second classroom " , designing course groups according to ability requirements, selecting research courses with scientific research characteristics in the course groups, reconstructing the teaching content of research-based teaching courses using knowledge graph technology, and carrying out traditional teaching and research-based teaching in a hierarchical and classified manner. In the training program, computer application ability, signal and information processing ability, embedded system development ability, Internet of Things application development ability, and comprehensive training of practical ability are constructed. The computer application ability module and the signal and information processing ability module focus on the application of knowledge, the embedded system development ability module and the Internet of Things application development ability module focus more on the innovation of analysis, design and research, and the comprehensive training module of practical ability focuses more on practical innovation" theoretical " level are the basis for students to acquire professional knowledge. Through systematic theoretical teaching, students can master the core knowledge system of the Internet of Things Engineering major[7]. For example, courses such as Introduction to Internet of Things Engineering, Computer Networks, and Sensor Principles provide theoretical support for students' subsequent learning and research.

"Experimental" level focus on cultivating students' practical operation and problem-solving abilities. Through experimental teaching, students can apply theoretical knowledge to actual operations and deepen their understanding and mastery of knowledge. For example, courses such as the Internet of Things Communication Experiment and the Embedded System Experiment allow students to discover, analyze and solve problems during the experiment.

"Practical training" level are project-oriented, and cultivate students' comprehensive practical ability and teamwork ability through the development and implementation of actual projects. For example, courses such as IoT system development training and smart home system design training allow students to exercise their abilities in a real project environment.

"Second classroom" provides students with a broader practical platform. Through subject competitions, scientific research projects, innovative and entrepreneurial activities, etc., it further broadens students' horizons and stimulates their innovative thinking and practical ability.

Selection and implementation of teaching methods For research-based teaching, the implementation targets are senior students in the third and fourth years of college, and the teaching

methods of "problem-driven theoretical teaching, case-driven experimental teaching, project-driven practical training teaching and competition-driven second classroom" are adopted. In theoretical teaching, problem-oriented, guide students to actively learn and think; in experimental teaching, through case analysis, let students master experimental methods and techniques; in practical training teaching, projects are used as carriers to cultivate students' comprehensive practical ability; in the second classroom, subject competitions are used as a driving force to stimulate students' innovative thinking and practical ability. For example, in the data analysis and mining course in the Internet of Things Engineering, teachers can raise a practical Internet of Things data analysis problem and guide students to solve the problem and put forward innovative ideas through steps such as consulting materials, analyzing data, and building models.

3.4. Practice of “1” educational practice approach

The third "1" refers to making full use of the school's mature "teaching, practice, creation, transformation and integration" educational practice approach, gathering high-quality resources for the integration of industry and education, and improving the scientific research innovation and practical capabilities of teachers and students through dual teaching, teachers and students learning together, teachers and students working together, teachers and students creating together, and teachers and students transforming together.

The connotation of the educational practice approach. The educational practice approach of "teaching, practice, innovation, transformation and integration" is an effective educational model summarized by the school in the long-term educational and teaching practice. Among them, "teaching" emphasizes the teaching concept centered on students, focusing on cultivating students' independent learning ability and innovation ability; "practice" focuses on practical teaching links, allowing students to master professional knowledge and skills through practical operations; "creation" encourages students to carry out innovative and entrepreneurial activities, and cultivates students' innovative thinking and entrepreneurial spirit; "transformation" is to transform students' innovative achievements into practical applications and promote industry-university-research cooperation; "integration" requires the organic combination of teaching, practice, innovation, transformation and other links to form a complete educational system.

4. The implementation effect of the “1141” research-based teaching model

4.1. The construction of exemplary courses has achieved remarkable results

Course selection and construction goals Select courses such as Introduction to Internet of Things Engineering, Internet of Things Communication Technology, Internet of Things System Development Training, and Internet of Things Innovation and Entrepreneurship Practice. These courses cover multiple levels such as theoretical teaching, experimental teaching, practical training teaching, and second classroom, which can fully reflect the characteristics and advantages of the "1141" research-based teaching model. By reconstructing the knowledge system, optimizing teaching content, and innovating teaching methods and means, these courses will be made into demonstration courses with distinctive research-based teaching characteristics, providing reference and reference for the reform of other courses. In the Internet of Things Communication Technology course, through knowledge graph analysis, complex communication technology knowledge points are sorted out and integrated to highlight key content and improve teaching efficiency. Secondly, innovative teaching methods and means, adopt problem-driven, case-driven, project-driven and other teaching methods to stimulate students' interest and initiative in learning.

4.2. Practical teaching has obvious effects

In the practice process of the "1141" research-based teaching model, the Internet of Things Engineering major has carried out comprehensive teaching reforms around clear goals, teaching procedures, curriculum systems and educational practice approaches.

4.2.1. Teaching Implementation

In theoretical courses, teachers guide students to actively think and explore through the teaching program of "problem-countermeasure-reflection-innovation". For example, in the course "Introduction to Internet of Things Engineering", the teacher raised the question of "how to achieve intelligent control of smart home systems". Students consulted materials, analyzed problems, proposed multiple solutions, and discussed and reflected in class. In experimental and practical training courses, students work in groups to carry out research-based learning around actual projects. For example, in the course "Practical Training of Internet of Things System Development", students design and implement a simple intelligent security system through a project-driven approach. From demand analysis to system development, and then to test optimization, students continuously improve their scientific research innovation and practical ability in practice.

4.2.2. Course Group Construction

According to the ability requirements, six progressive course groups have been constructed to form a complete ability training system. The basic course group lays a solid theoretical foundation for students; the professional core course group cultivates students' comprehensive application of professional knowledge through research-based teaching; the experimental and practical training course group strengthens students' practical operation ability; the second classroom course group further stimulates students' innovative thinking through competitions and scientific research projects. For example, in the "Internet of Things Application Development" course group, students combined theoretical knowledge with practice by participating in the "Smart Home System Design" project, and finally won excellent results in the provincial Internet of Things design competition.

4.2.3. The practice of “teaching, practice, creation, transformation and integration”

Through in-depth cooperation with enterprises, the school provides students with rich practical resources. Under the guidance of enterprise mentors, students participate in the development of actual projects, which not only improves their practical ability, but also transforms research results into actual products, realizing the organic combination of "teaching, doing, creating and transforming".

5. Conclusion

"1141" research-based teaching model aims to improve students' scientific research innovation and practical ability. By clarifying teaching objectives, designing teaching programs, building a curriculum system and using educational practice methods, it provides new ideas and methods for the teaching reform of the Internet of Things Engineering major. Practice has shown that this model can effectively improve students' ability level and comprehensive quality, and provide strong support for the certification of engineering education majors. However, the implementation of research-based teaching still faces some challenges, which requires teachers and schools to work together to continuously improve the teaching model, improve the teaching quality, and lay a solid foundation for cultivating high-quality innovative engineering talents.

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